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USING EVERYDAY EXPERIENCES
IN TEACHING SECONDARY MATHEMATICS IN MALAWI:
POSSIBILITIES AND CONSTRAINTS FOR CHANGE

Willy Weston J. Mwakapenda
B.Ed., B.Sc (Hons.) (Malawi), M.Sc. (Ed.) (Witwatersrand, Johannesburg)

A thesis submitted in fulfilment of the requirements of the Degree of

Doctor of Philosophy
Faculty of Education
School of Scientific and Developmental Studies
Deakin University, Melbourne

January, 2000
DEAKIN UNIVERSITY

CANDIDATE DECLARATION

I certify that the thesis entitled *Using Everyday Experiences in Teaching Secondary Mathematics in Malawi: Possibilities and Constraints for Change* submitted for the degree of **Doctor of Philosophy** is the result of my own research, except where otherwise acknowledged, and that this thesis in whole or in part has not been submitted for an award, including a higher degree, to any other university or institution.

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ABSTRACT

Proponents of socially and culturally oriented mathematics education have argued that teaching approaches which value and connect with the learner's prior knowledge and everyday experience are more likely to promote active, meaningful, relevant and liberatory learning than approaches which rely on transmission and abstract presentation of mathematical content.

In Malawi, proposals to reform the outdated secondary mathematics curriculum have been made with the aim of aligning mathematics instruction with the social and political changes in the current Malawian society. Using a case study approach, this study investigated the extent to which everyday experiences could be used as a vehicle for changing the learning and teaching of secondary mathematics in Malawi. The study was collaborative, taking place over a period of five months in severely overcrowded and poorly-resourced classes in two schools. It involved three mathematics teachers in a cycle of planning and teaching mathematics lessons based on the use of everyday experiences, and observation of and reflection on these lessons, in order to document the effects of using everyday experiences on student learning and teachers' teaching practices. The data was collected through student questionnaires; classroom observations and fieldnotes; interviews and reflective meetings with teachers; and informal meetings with key education officials in Malawi. Mathematics examination results from students involved in this study and a corresponding group from the previous year were collected. A reflective and critical approach was adopted in the interpretation and discussion of the data.

Teachers' participation in this study resulted in heightened awareness of their teaching roles and the value of linking school mathematics with everyday experience. The study also shows that students found mathematics interesting and important to learn despite their lack of success in it. In addition, the study documented a number of constraints to change in mathematics instruction such as teachers' focus on mathematics content and examination requirements, and students' resistance to inquiry learning. It also recorded possibilities and barriers to collaboration both between teachers and researchers, and teachers themselves.

The findings of this study are timely since they could serve to inform the reform of the Malawian secondary mathematics curriculum currently being undertaken, which began without a critical examination of the classroom conditions necessary to accommodate a socio-politically relevant mathematics education.
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CHAPTER 1

INTRODUCTION

1.1 Everyday experiences in mathematics education – An opportunity for change

This study investigated the extent to which everyday experiences can be used as a vehicle for changing the learning and teaching of secondary mathematics in Malawi.

During the past three decades, there have been widespread calls for change in school mathematics in reaction to inappropriate content and low levels of achievement among students. Poor achievement in mathematics has limited students’ access to further education, employment, and active participation in democratic and increasingly technological society. For many students, learning mathematics is a school-only affair. They see mathematics as a difficult subject which can only be enjoyed by a few privileged individuals.

Major reform documents such as Cockcroft (1982), National Council of Teachers of Mathematics (1989) and Australian Education Council (1991), have outlined a new vision of mathematics, new conceptions of mathematics learning, and new pedagogies for teachers to assume in order to facilitate mathematical understanding and meaning making among students.

Members of the mathematics education community, including university mathematicians and educators, researchers, policy makers and practitioners, have responded to the widespread dissatisfaction in mathematics achievement in many different ways (see, for example, Damerow, Dunkley, Nebres & Werry, 1984; Keitel, Damerow, Bishop & Gerdes, 1989; Davis & Maher, 1993; Julie, Angelis & Davis, 1993; Gatsos, 1998). However, there is consensus about the need to change mathematics teaching and learning to reflect the interests and cultures of society and to connect school mathematics and students’ experiences in their everyday lives. It is argued that teaching strategies which involve students in critical thinking, encourage students’ own strategies and connect to their existing knowledge and experiences, are more likely to result in effective and meaningful learning. This way of learning has the potential to make students participate actively and become more interested in mathematics. Ascher and D’Ambrosio (1994) have pointed out that connecting school mathematics to everyday experiences “broadens the realm of the possible for students [and] provides a
different way to introduce students to mathematical ideas even if they were put off by the algebraic/symbol manipulation aspects of school mathematics” (p. 42). Using everyday experiences in teaching mathematics provides a rich context for learning and a natural connection between students’ learning in school and familiar situations in their everyday lives. When the connections are made explicit, students can begin to make a mathematical analysis of otherwise taken-for-granted aspects of everyday life. This has the potential to empower students to take action on problems confronting their everyday living.

In contrast to developments in mathematics education in many parts of the world, mathematics education in Malawi has remained unchanged for many years. It is still based on a colonial model of education. Students view mathematics as a body of pre-existing knowledge and skills that have been developed by others and are best learned by memorisation and repeated practice. They learn mathematics by doing exercises from the textbook. There is very little problem solving, problem posing, investigation or discussion among students about the mathematical concepts they are learning, why they are learning them, and whether the concepts bear any social or cultural connections to their everyday lives. These problems, together with the fact that most Malawian classrooms are severely overcrowded, have limited teaching and learning materials and have inadequately qualified teachers, make the provision of quality learning in mathematics difficult to achieve.

Following recent politically-driven calls to reform secondary education in general in Malawi, the Ministry of Education has proposed a review of the current curriculum in order to provide education which is best suited to the needs of the Malawian society (Ministry of Education & Malawi Institute of Education, 1995). However, there has been very little attempt to change mathematics education in Malawi, in spite of the developments stated above (Heedens, 1995a). While proposals for change in mathematics teaching and learning have been made in line with the reform in secondary education in Malawi, these proposals have not been supported by any empirical studies with students and teachers in Malawian classrooms. Such proposals have focused on policy and have been at a theoretical level. The processes and outcomes of mathematics education in practice have yet to change in any significant way. Little is known about what linking mathematics learning to students’ everyday experiences and society might mean in actual practice in Malawian schools. This provided the direction for this research.
1.2 Background to the study

The need to do this research grew out of my personal experiences in learning and teaching mathematics and my observation that mathematics as it is practised in schools in Malawi does not adequately link itself to students' everyday experiences and realities. In the following sections, I describe the critical incidents which led to the current study. These occurred during my primary and secondary education, how I was introduced to teacher education in Malawi, and my interaction with the mathematics education literature during my postgraduate study in South Africa.

1.2.1 My primary and secondary school years

I attended primary school\textsuperscript{1} from 1973 to 1982. My teachers spoke highly of me because I often did well in class. In year seven of primary, I was appointed class captain and my duties included making sure that the class did not make noise during class hours. As class captain, my role was mainly about classroom management and control, and ensuring that the blackboard was kept clean at all times after the teachers had finished their lessons.

In mathematics lessons, we repeatedly read through copious notes and examples and used these examples as a guide in solving routine exercises. Our teachers deliberately set hard problems in tests to ensure that no pupil got all the questions correct. For example, a teacher would take a problem from a Durell textbook, knowing very well that we did not have access to such a textbook. This gave an impression that mathematical knowledge was "hidden" and only accessible to learners by listening to the teacher. Interestingly, when demonstrating solutions to arithmetic problems, our teacher always said that we did not need to go to school in order to know mathematics.

Our mathematics tests often consisted of "mental arithmetic" and "speed and accuracy" tests. These had short questions and needed to be done in twenty minutes. Emphasis was placed on getting through the questions quickly, and on practising for speed and accuracy in preparation for the national examinations. For many pupils, mathematics was just a subject we had to learn in the primary school syllabus. Repeated practice and following the teachers' examples was considered to be the most efficient way of succeeding in mathematics.

My experiences at secondary school were similar to those of primary. We were continually urged to work hard, to solve as many problems as possible from the

\textsuperscript{1} Primary education in Malawi starts at about the age of six. Very few Malawian children have access to formal pre-school education.
textbook in order to succeed in mathematics. Students who did not do well in mathematics were advised to join the “dull man’s club” in which the less able students received remedial instruction and coaching from more able peers.

1.2.2 At the University of Malawi: Learning to teach

Due to my successful experiences at primary and secondary schools, I developed an interest in teaching mathematics. I majored in mathematics and studied educational foundations (psychology, sociology and philosophy of education), and teaching methods in my teacher education courses. In the teaching methods course, we planned lessons and taught each other in micro-teaching sessions. However, we had very little contact with the real classroom for which we were being prepared to work. The only teaching practice we did during our five-year university education was a three-month teaching practice in school during the third year.

Our teacher training courses rarely allowed us to reflect on mathematics, its value and the best way of learning it. There was often a dichotomy between theory and practice. Although our teacher educators advised us to teach for understanding rather than recall, one teacher educator often urged us to listen and write down what he said as it was very important and would certainly come up in the examinations. Our educators advocated discussion among students while their own lectures were teacher-directed, and allowed little active student participation and critique.

1.2.3 My teaching and postgraduate experiences

I taught mathematics at a secondary school in Northern Malawi for about a year after completing my initial teacher education in 1992. Given the pressure to prepare students for examinations, my teaching practice, like that of most teachers in the school, lacked reflection. Emphasis was placed on completing the syllabus since this was what teachers felt they were being paid for. The curriculum and teaching styles were not examined critically. Teaching and learning conformed to unquestioned school norms and ensured competition among students in school and national examinations.

In January, 1993, due to my interest in learning about mathematics and teaching, I joined the University of Malawi as a staff member in the Malawi Mathematics and Science Teaching Improvement Project (MAMSTIP). The project was responsible for providing in-service training to secondary school science and mathematics teachers. As part of the professional development of the project staff, I completed a Master of Science at the University of the Witwatersrand in
South Africa. During the course, I was exposed to various research publications in a unit concerned with learning theories in mathematics education. A key aspect of these publications concerned discussions about the notion of situated cognition. It is claimed that the nature of a person's knowledge is inextricably tied to the contexts in which that knowledge was acquired (Carrabber, Carraher & Schliemann, 1990; Lave, 1985; Lave, 1988; Putman, Lampert & Peterson, 1990). As a consequence of this exposure, I became interested in understanding how street vendors cope with mathematics in their street-selling practices. I then carried out an investigation into the ways in which street vendors use mathematics in their selling business in Hillbrow, Johannesburg (Mwakapenda, 1995). Two key findings were noted. The first was that mathematics serves as an organisational tool for the vendors. This was evident from the use of unit price, fixing small packs of tomatoes at a price of one South African rand per pack. Secondly, irrespective of age and qualification, all the four vendors involved in the investigation demonstrated great success in the use of mathematics in their selling practices. However, there are differences between the street-vending and the ordinary classroom context, particularly in terms of the purposes for which mathematical computations are done. In the street context, computations are done to monitor the sales — to make sure that the sellers do not make losses. The computations arise as a result of the emerging demands of the selling process. The computations are not done for their own sake. They are done with a specific purpose and are of immediate importance to the life of the person involved in the business. As a result, individuals involved in street selling practices try to understand the problem situations requiring the use of mathematics and generally succeed in their computations.

On the other hand, traditional classroom tasks tend to be disconnected from everyday life. Children are asked to solve mathematics problems which may not have any connection with what they do or observe in their everyday lives. It needs to be noted that there is a tendency for the same children (who are not successful in school mathematics) to succeed in mathematics related activities in their everyday lives. In the literature, school children have been reported to be more successful at solving problems that are related to their everyday activities than at solving similar problems based on abstract and artificial situations.

My experiences during the Master's course made me conscious of the opportunities I missed in my previous learning, student teaching and my subsequent role as a teacher. My reading of the mathematics education literature led me to reflect on the learning situations I encountered as a learner, and, in particular, on the absence of deliberate attempts on the part of my Malawian teachers to link school mathematics and everyday experience.
Banda (1982) pointed out that secondary education in Malawi is designed to train individuals for paid employment and to enable them to gain access to further education. However, many students do not pass mathematics. Those who do so, do not necessarily succeed in gaining employment owing to a lack of employment opportunities. For similar reasons, many of those who pass in school mathematics do not gain a place in further education. This is at the very least confusing for learners and those engaged in their education. At worst, it is socially divisive. In Fasheh's (1989) terms, the education they receive fits them to live in a "world created by education and hegemony", leaving them "blind to its ideological dimension, to the relationship between the knowledge transmitted to [them], and power" (p. 85).

This blindness, characteristic of hegemonically educated Third World people, [leaves them] unfit to live in the real world, in the real environment. Hegemony is not only characterised by what it includes, but also by what it excludes; by what it renders marginal, deems inferior, and makes invisible. The effect of hegemonic education is such that it is almost possible to define the real environment by what formal education marginalises or excludes. (Fasheh, 1989, p. 85)

Whereas I was successful in school and in learning mathematics, this was not the case for the majority of students during my time. It is still not the case for many of them who continue to find mathematics inaccessible, boring and meaningless.

The above experiences in my learning, teaching and postgraduate studies in South Africa have motivated me to participate in changing mathematics learning and teaching in secondary mathematics in Malawi using everyday experiences as a vehicle for stimulating this change. I considered that the best way for me to engage in my research was to put into practice some of the ideas I had gained in order to contribute to the improvement of teaching and learning of mathematics in schools.

As a result of my research experiences in South Africa, I had gained an appreciation of the ways researchers have addressed issues of active participation and critical pedagogy and connected these to cultural values, and more specifically, to social and political dimensions of mathematics education. I felt I could play a stimulating role in changing the practice of mathematics education within Malawian schools.

While I had a lot of enthusiasm for carrying out such research, the success of my investigation would depend on what the teachers involved in the study valued most. There was therefore a need to do this research in teachers' ongoing practice so that any developments noted could be adapted and refined by those who would be most affected by the changes, the classroom teachers themselves. This would make the research meaningful to them and enhance the possibility that
they could implement the changes in ways consistent with their own knowledge about mathematics, values and beliefs about teaching and learning.

I considered that the improvement of students' learning required teacher-researcher collaboration, hence I would need to work with teachers who shared similar concerns about classroom conditions in Malawi. There was a need to learn from the wisdom of their practice (Shulman, 1987). Such research would act as a seeding process for teachers, curriculum developers and mathematics educators.

1.3 Overview of the study

This study addressed the following main question:

To what extent can everyday experiences be used as a vehicle for changing the learning and teaching of secondary mathematics in Malawi?

This research was carried out through an empirical investigation using case study methods to explore the effects of the use of everyday experiences on students' attitudes to, beliefs about, and knowledge of mathematics, and their participation in mathematics learning. It also explored changes in teachers' classroom practices and their perceptions of mathematics teaching as a result of their participation in the research intervention. The study was collaborative, taking place over a period of five months in severely overcrowded and poorly-resourced classes in two schools. It involved three mathematics teachers in a cycle of planning and teaching mathematics lessons based on the use of everyday experiences, and observation of and reflection on these lessons, in order to document the effects of using everyday experiences on student learning and teachers' teaching practices. The data was collected through student questionnaires; classroom observations and fieldnotes; interviews and reflective meetings with teachers; and informal meetings with key education officials in Malawi. Mathematics examination results from students involved in this study and a corresponding group from the previous year were collected. Reflective and critical approaches were adopted in the interpretation and discussion of the data. I considered the need to be responsive to problems as they are perceived in the particular situation by students and teachers an important aspect of the research.

The changes to student learning and teachers' teaching practices noted during the investigation were limited. This was attributed to the limited time frame of the study and institutional constraints in the participating schools. The process of the investigation revealed much about the constraints acting upon both students and teachers. The investigation became, therefore, essentially a study designed to
describe the current status of secondary mathematics education in Malawi and to explore the possibilities and constraints for change in mathematics learning and teaching when everyday experiences are used as a vehicle for initiating this change. This type of study has rarely been reported in the mathematics education research literature. It is particularly appropriate for the discussion and interrogation of curriculum change, and, in particular, for locating local and global aspects of secondary mathematics education which need to change in Malawi.

1.4 Organisation of the thesis

The present chapter describes the origins of this research. Chapter 2 describes the Malawian educational context in which the research was implemented. Change in mathematics teaching and learning cannot take place without considering the broad schooling context and the society in which it occurs. There was a need to understand the context of teaching and learning in Malawian schools and especially the constraints on that change process in practice.

In Chapter 3, I review four perspectives on the use everyday experiences in teaching mathematics. These describe learning as a purposeful activity which takes place in a social, cultural and political context. The literature review provides a broad framework of mathematics learning and indicates possibilities for change in learning and teaching when everyday experiences are used in mathematics instruction.

Chapters 4 outlines the methodology used to answer the research question, the ethical considerations and the data analysis methods. I use the notion that learning is a social, participatory and communicative practice (Lave, 1996; Mezirow, 1990). This framework allowed me to use a case study design which provides a facility for examining change in learning in the classroom. In Chapter 5, I describe the conduct of the study in two selected schools in Malawi: one Distance Education Centre and one conventional secondary school.

Chapter 6 presents an analysis of the students' and teachers' data using qualitative and descriptive methods. Insights and issues emerging from the participants' data are presented and reflected on.

In Chapter 7, I describe the results of this analysis. The chapter indicates that the intervention had produced little immediate change in students' performance in national examinations and teachers' teaching practices. It became apparent from my own observations and the participants' questionnaire and interview data that there were clearly identifiable sets of constraints operating in both schools. The data provided me with participants' thinking about what might change in order to make school mathematics a more worthwhile experience for them. I have
outlined the conditions and possibilities for change in mathematics teaching and learning informed by the context in which the research was conducted.

Chapter 8 discusses the key issues that have emerged from doing this research and what I personally achieved in my learning journey. The dilemmas faced in doing this research and the key possibilities and constraints for change in secondary mathematics education in Malawi are discussed. Recommendations for reform in mathematics learning and teaching based on the use of everyday experiences are presented, together with areas for further investigation.
CHAPTER 2

THE RESEARCH CONTEXT: MALAWI

This chapter discusses the educational context in which this study was conceptualised. It demonstrates that while there are positive developments in the political context of Malawi, current efforts in secondary school education, and mathematics education reform in particular, have not adequately utilised and built on these developments in their respective curriculum review processes.

2.1 Malawi: General background

Malawi, formerly called Nyasaland under British colonial rule, is a poverty stricken land-locked Southern African state with an estimated population of 12 million of which more than 80% is rural. Its annual population growth rate is nearly 3.2%. Malawi borders Tanzania to the north, Zambia to the west, and Mozambique to the east, south and south west. It has an area of 119 140 square kilometres, nearly 20% of which is occupied by Lake Malawi.

Malawi has an average annual per capita income of K8 800 (US$200). She has been rated the eighth poorest country in the world in terms of economic performance (World Bank, 1999). Malawi has a predominantly informal employment structure, with 82% of the labour force involved in small-scale agriculture, 9% in industry & services, 5% in estates, and 4% in the informal sector (Malawi Government & United Nations, 1993, p. 119). Malawi's economy is based on agriculture. Characteristic of most governments in the developing world, the Malawi government's social and economic development plans are supported mainly through donor aid, notably from the International Monetary Fund and the World Bank.

The official language is English. English is used in instruction from about standard 3 (third year) of primary school. The national language is Chichewa. There are more than ten other languages spoken by native Malawians. Malawi has a literacy rate of approximately 40% (Malawi Government & United Nations, 1993, p. xix), which is lower than the average of 47% for countries in Sub-Saharan Africa.

Malawi gained independence from Britain in 1964. For thirty years, Malawi was under a one-party dictatorial government. The government ran on the Malawi Congress Party policy which had four cornerstones: unity, loyalty, obedience and discipline. Alternative views concerning national and education policy issues
were suppressed and could not be publicly raised by Malawians living in the
country. Obedience and rule-following were enforced in every aspect of
Malawian activity by the Malawi Young Pioneers, a military wing of the Malawi
Congress Party. Under the one-party government, Malawi was essentially a
closed society in which the prevailing regime suppressed every possibility that
things could change or be done differently (Donge, 1995). Until 1997, Malawi
only had one radio station and no national television. This ensured government
control of information so that most of the leadership’s operations lacked
transparency and public accountability.

In 1994, following international sanctions on humanitarian aid and national and
international pressures for political reform, a new multi-party government was
elected. This government is led by the United Democratic Front party.

### 2.2 Education

Formal education in Malawi was introduced by the Scottish missionaries in 1875.
The primary aim of this education was to teach native Malawians to read and
write so that they could facilitate the spread of Christianity (Banda, 1982).
When Malawi became a British protectorate in 1891, the colonial government
used the same education system which aimed at producing a small number of
people who were required to serve in various government, industrial and
commercial sectors. This utilitarian and job-training role of education was
emphasised during the formation of the first colonial Department of Education in
Malawi in 1920 (Banda, 1982).

Education in Malawi from 1875 to 1964 when Malawi gained independence had
as its aim the production of individuals who would become “evangelists, clerical
and administrative staff for evangelical, civic and commercial activities” (Msiska
& Zoani, 1996). Even after independence, education in Malawi still had
colonialist and authoritative elements. The aims of education in Malawi needed
to “support and serve the precepts and Cornerstones of the Republic of Malawi
in a spirit of unswerving loyalty and dedication” (Ministry of Education, 1985,
p. 4). Harber (1990) points out that, since the 1970’s, the Malawi government
had taken a firm position prohibiting learner-centred and progressive pedagogies.
The former President of Malawi stated that

> The so-called methods of teaching which allowed pupils to please
themselves, to pick up what they liked and leave out what they did
not like, have no room in African society because under ordinary
village life children are never left to themselves to do as they please.
(Harber, 1990, p. 33)

In his analysis of education syllabuses in Malawi, Hawes (1979) notes that
The "four cornerstones" of the Malawi Congress Party: unity, loyalty, obedience and discipline, match ill with the "spirit of inquiry" which the country's 1966 syllabus announced as the guiding principle for primary education syllabus change. (p. 35)

Education for inquiry conflicts with the cultures of many societies in non-western countries. Suffolk (1989, p. 104) has commented that teachers in many developing countries are expected to have a formal relationship with their students, and to be "respected" because of their age and position. Students are expected to be quiet and submissive.

According to Msiska and Zoani (1996), Malawi continued to plan its education development activities on the basis of equipping people with the formal education necessary for securing salaried jobs of various types.

Primary education starts from the age of five and spans over a period of eight years. Secondary school education takes four years with the first two years making up the Junior Certificate of Education (Forms 1 and 2), and the last two years being for the Malawi School Certificate of Education (Forms 3 and 4).

The new government introduced free primary education in 1994 in an effort to boost the literacy rate — that is, to enable more Malawians to read and write. It is expected that primary education will be compulsory in the future (Malawi Government, 1995, p. 20).

The government, as a result of the introduction of free primary education, has embarked on building an extra 39,000 primary schools. It has recruited 22,000 unqualified teachers. Ways of training these primary teachers are being explored.

At present, Malawi has only two universities: the University of Malawi, with a student population of about 3000, and the newly opened University of Mzuzu which has only one department but will also have a faculty of education focusing on the provision of distance teacher education courses. Currently, the faculty of education at the University of Malawi and the Domasi Secondary Teachers Training College are the only two institutions officially responsible for training secondary school teachers. Only about 120 teachers a year graduate from the University of Malawi while Domasi Teachers College produces more than 250 teachers a year, all of whom are only at a diploma level.

Very little inservice teacher education is provided. In 1990, the University of Malawi and the Free University of Amsterdam initiated an inservice teacher education project: the Malawi Mathematics and Science Teaching Improvement Project. From 1990 to 1996, the project has provided residential inservice courses for more than 260 mathematics and science teachers. However, due to financial
constraints, the project activities have not been institutionalised as planned (Malawi Mathematics and Science Teaching Improvement Project, 1996).

### 2.2.1 Secondary education

Secondary education in Malawi was introduced in 1940. Since its introduction, secondary education has only been accessible to a small proportion of students graduating from the Primary School Leaving Certificate level. For example, the percentage of students selected to secondary school averaged a meagre 10% between 1962 and 1965 (10.6% of 9863 students in 1962, 12.4% of 12 812 in 1963, 7.6% of 32 936 students in 1965). From 1965 to date, the primary to secondary school transition rate has been between 8 and 10%. The number of students completing primary school in Malawi is more than 100 000 every year. The low transition rate implies that more than 90% of primary school leavers are unable to enter formal secondary education. This clearly indicates that the provision of secondary education in Malawi has been far from adequate.

The shortage of secondary school places for the growing school going population contributes to the low provision of secondary education in Malawi. However, it is also due to previous education policies. For example, the 1985-1995 Education Development Plan (Ministry of Education, 1985, p. 5) states the following:

> Secondary education opportunities will remain geared to serving economic development rather than social demand . . . There will continue to be limited access to full time secondary education for primary school leavers.

Secondary education has mostly been geared towards meeting employment needs. Msiska and Zoani (1996) have argued that since agriculture and paid jobs are the only two alternative and reliable forms of employment for most Malawian children graduating from formal educational institutions, this state of affairs only facilitates the production of social and economic inequalities. Msiska and Zoani (1996) argue that for an emerging country like Malawi, the fact that only a few students get a secondary school education means an enormous “waste of valuable human capital required to engender social, political and economic development” (p. 3).

However, the government of Malawi has attempted to reduce this transition gap in addition to developing educational plans designed to meet the economic and political realities of many Malawians. Mpheluka (1980) explains that the government has responded to the great demand for education in rural areas where the vast majority of the Malawians lives. According to Mpheluka (1980), the shortage of resources, both in manpower and financial terms, caused the government to find alternative methods of providing education . . . Therefore, distance education which had proved to be
cheaper, comparatively, in other countries (Australia, New Zealand and Sweden) was introduced to be used in the field of formal education. (p. 37)

Because of the expansion in primary education, the Malawi government has embarked on a foreign-aided program of building an extra 250 secondary schools by the year 2005 (Malawi Government, 1995). This shows that Malawi is expanding her secondary school system to meet the social demand for access to education.

2.2.2 Distance Education

The need to provide secondary education to a greater population of Malawians prompted the Malawi government to establish the Malawi Correspondence College in 1965. According to Nankwenya (1974), the College was established on the understanding that correspondence is a method of teaching in which the teacher bears the responsibility of imparting knowledge and skills to a student who does not receive instructions orally, but who studies in a place and at a time determined by his/her individual circumstances. It is a special technique in which the student is taught by at least two teachers: the writer of the course of instructions, and the instructor who receives the student’s work for evaluation and who gives, through his/her comments on it, whatever further teaching is necessary. In some cases, the writer and the instructor may be the same. (p. 38)

Mpeluka (1980), Perry and Rumble (1987), and Msiska and Zoani (1996) have pointed out that correspondence education means educating at a distance, with minimal face-to-face interaction between the learner and the teacher for the major part of the course of instruction. This places emphasis on taking education “where people are, given their prevailing circumstances rather than taking people to where formal education is as the case with conventional forms of schooling” (Msiska & Zoani, 1996, p. 5). However, although the learner and the teacher are not in contact for a major part of the learning process, the use of communication devices such as postal or electronic mail, telephone, radio and television provides for a two-way dialogue and feedback. According to Msiska and Zoani (1996), it is the understanding that distance education is meant to be a two-way communication between the teacher and the learner that prompted the Ministry of Education to rename the Malawi Correspondence College as Malawi College of Distance Education.

Students enrol in distance learning courses and the Malawi College of Distance Education is expected to provide students with programmed self-instructional materials. These students meet in centres called Distance Education Centres, where they are expected to receive guidance from appointed teacher-supervisors.
Over time, these learning materials have become so scarce that most students do not access them during their school career, for various reasons. Teachers (supervisors) in these centres have resorted to formal teaching instead of supervising. Firstly, students in these centres use the same syllabus and write the same examinations as those in conventional secondary schools, hence there is pressure on Distance Education teachers to make sure that their students are adequately prepared for the national examinations. Secondly, teachers in these centres do not have any training in distance education methods. They are recruited from the pool of existing primary school teachers. Given that these teachers have inadequate training in any specific area, their previous exposure to the teaching profession and the lack of student materials forces them to teach rather than supervise as required by the distance education policy. Thirdly, most students in these centres are young (about 13 years) and lack the independence and confidence needed to enable them to study effectively on their own.

These factors have led to a strong social, political and community demand for students to be taught rather than study on their own. Nevertheless, Mkandawire and Jere (1988, p. 140) have commented that distance learning has provided access to secondary education for the majority of primary school leavers “who are unable to be placed in the formal school system”. It has been estimated that there are three times as many students in Distance Education Centres as in conventional secondary schools (more than 120,000 students in 350 centres compared to about 40,000 students in about 100 secondary schools).

While distance education has provided more “opportunities” for learning and consequently facilitated the “democratisation” of the education process in Malawi (Mkandawire & Jere, 1988), it has been observed that the quality of instruction and attainment of examination results in the Distance Education Centres have not been as good as those in the secondary school system (Chimwenje, 1997a; Msiska & Zoani, 1996).

**2.2.3 Distance Education Centres and conventional secondary schools: A comparison**

In this section, I describe the differences in the provision of secondary education in Distance Education Centres and conventional secondary schools. The differences in these two education systems are reflected by the type of students and teachers, learning resources, and students’ performance in examinations.
2.2.3.1 Students and teachers

Students in conventional secondary schools are selected from the top 10% who pass Primary School Leaving Certificate examinations. Secondary schools have an average of 65 students per class. However, enrolments in Distance Education Centres are enormous due to reasons outlined above. A typical class in these centres has between 100 and 200 students. Students in both Distance Education Centres and secondary schools are normally quiet. They listen to teachers and copy examples and notes from the blackboard. This is a major aspect of their learning process.

Teachers in conventional secondary schools normally have a university qualification — that is, a Bachelor of Education degree or a Diploma in Education. However, a large proportion of them do not possess a teaching qualification. In contrast, the majority of teachers in Distance Education Centres have a primary teaching certificate. They are neither given any in-service training on how to teach in Distance Education Centres (an equivalent of secondary schools), nor are they given any orientation on distance learning methods. Nevertheless, teachers in these centres have similar responsibilities as those of their counterparts in the secondary schools.

It needs to be noted that teachers in both Distance Education Centres and secondary schools do not benefit from any inservice professional development due to its non-existence. Extra professional development is irregular and is provided occasionally (once a year) during the annual conferences of the Science Teachers Association or Mathematics Association of Malawi.

2.2.3.2 Teaching and learning resources

In Distance Education Centres and conventional secondary schools, teachers typically have a syllabus and textbook as the only resources for teaching. Extra resources such as professional teaching packages and other guides are scarce, especially in Distance Education Centres.

Most Distance Education Centres do not have buildings of their own. They usually use primary school blocks. These centres have very little learning time compared to conventional secondary schools. Most centres operate in the afternoons, between 1:00 and 5:30 pm. Students spend most of their time either at home or walking to and from school. This means that they have very limited time to share their learning experiences while in school.
In spite of these conditions, most of the students are still determined to learn because of the value they or their guardians attach to secondary education.

Classrooms in Distance Education Centres do not have enough desks for all students. Most students sit on the floor. Very few Distance Education Centres have science laboratories or libraries. Textbooks are not provided to students. Instead, students contribute K60.00 tuition fees (about US$2.00) in order to receive programmed learning booklets from the Malawi College of Distance Education. These booklets are designed to be self-instructional, with exercises and solutions provided at the end of each section. However, these materials are not sent to students in sufficient time, and when they are, they are usually not sufficient in number. Hence most students have to share the few resources they get (Msiska & Zoani, 1996). In contrast, students in conventional secondary schools are given textbooks in addition to having access to a school library and science laboratory, and have relatively better equipped classrooms.

2.2.3.3 Students’ performance in national examinations

The above review of the situation in Distance Education Centres shows that teaching and learning is beset with enormous problems. Basic facilities for learning and teaching are in very short supply. As Chimwenje (1997) explains, these constraints contributed to enormous differences in students’ performance in certificate examinations, particularly at the Malawi School Certificate (Form 4) level. Figure 2.1 below shows the distribution of the percentages of Form 2 and Form 4 students in Distance Education Centres and secondary schools (SECs) who were awarded the Junior Certificate and Malawi School Certificate, respectively, between 1990 and 1996.

As can be seen in Figure 2.1, the performance of students in the Malawi School Certificate of Education (MSCE) is poorer in Distance Education Centre (DECs) than in secondary schools (SECs). Between 1990 and 1996, the average percentage of students who were awarded the MSCE in Distance Education Centres was 22% while that of students in secondary schools was 62%. However, at the Junior Certificate (JCE) level, the differences in the percentage passes are much smaller. An average of 74% of the students were awarded the JCE certificate in Distance Education Centres while the average was 86% for students in secondary schools.
Figure 2.1: Distribution of percentages of Form 2 and Form 4 students who were awarded certificates from 1990 to 1996

A similar trend in performance is observed in mathematics examinations. Figure 2.2 shows the distribution of the percentages of students who passed mathematics at the Junior Certificate and Malawi School Certificate levels between 1992 and 1996.

As can be seen from Figure 2.2, there are enormous differences in students' performance in mathematics examinations in Distance Education Centres compared to conventional secondary schools. An average of 76% and 84% of the students in Distance Education Centres and secondary schools, respectively, passed mathematics at the Junior Certificate (Form 2) level between 1992 and 1996. At the Malawi School Certificate (Form 4) level, only 16% of students in
Distance Education Centres passed mathematics compared to an average of 53% in secondary schools over the five-year period.

*Figure 2.2: Distribution of percentages of Form 2 and Form 4 students who passed mathematics between 1992 to 1996*

These differences are a result of many factors such as the nature of the examinations taken, the quality of instruction and disparities in resource allocation between Distance Education Centres and secondary schools. Nevertheless, as Msiska and Zoani (1996) explain, these examination results increase social inequalities in secondary education. Students’ performance in mathematics in particular, illustrates the role of mathematics as a filter and selection tool for placing people in different workplace fields.
To alleviate the above problems, the Malawi government is planning to formulate a policy on distance education. This policy is expected to articulate clear mechanisms for resource allocation in Distance Education Centres and secondary schools, as well as for the professional development of teachers in the secondary education system. This can be seen in the Malawi Government's (1995) Education Development Plan. However, most of the strategies proposed in the Education Development Plan aim at solving problems related to lack of material resources such as classroom space and textbooks — that is, issues of quantity and access to education rather than quality. Although issues of quality and access to education are related, no explicit attention is given to the provision of quality teaching and learning in the new Education Development Plan.

Recent developments in education in Malawi have paid some attention to the provision of quality secondary school education. These are described below.

2.3 Recent developments in secondary education

Due to the new democratic structures in Malawi, the period between 1994 and 1997 has witnessed four developments in secondary education. Two of these have been in secondary education in general, while the other two have focused on mathematics education. These are discussed in this section.

2.3.1 Secondary school curriculum needs assessment survey

In 1994, the Malawi Institute of Education conducted a secondary curriculum needs assessment survey. This survey was commissioned by the Ministry of Education and had the aim of determining the "needs of the learners which are not met by the existing secondary school curriculum" (Chimwenje, Bisika & Makuwira, 1995, p. iv). The survey was quantitative and involved collecting data, using questionnaires and some structured interviews, from 110 teachers, 330 students, 22 heads of schools in 22 secondary schools, 110 students who were no longer in school and over 100 parents and employers in Malawi.

The survey required students to answer a number of questions such as:

Which secondary school subjects do you consider relevant to your future life? ... Do you think the secondary school curriculum offers you enough skills to be on your own after completion of the course? ... Do you think the secondary school education helps you to: (a) discover vocational skills/interests? (b) earn a good salary? (c) prepare for a career? (d) be of service to community? (e) gain general knowledge? (f) develop leadership skills? List down subjects which you feel some information needs to be added or removed ... What additional subject(s) would you suggest be added to the current curriculum to make it more relevant to your needs? (Chimwenje et al., 1995, pp. 32–35)
Some of the questions the survey asked teachers were:

As an educator, you have the liberty to criticise other subjects. Would you please list down subject(s) which you feel a review of content is necessary considering the present social, economic and political changes . . .

In your opinion, are the knowledge and skills the students are acquiring in secondary school prepare them for the world of work? (Chimwenje et al., 1995, p. 37)

Among many questions, the employers were asked to comment on whether the secondary school curriculum should offer pre-vocational courses.

Most of the teachers, parents and employers surveyed indicated that the current curriculum does not equip secondary school graduates with skills necessary for the job market. Chimwenje et al. (1995) concluded that “the secondary school curriculum does not offer pre-vocational courses”. They claimed that “current thinking in education however points to the need to offer pre-vocational programs in the secondary school curriculum, the argument being that such programs prepare the youths for the world of work” (p. 25). Chimwenje et al. (1995) also concluded that the current secondary school curriculum does not address the needs of the learners because it has “irrelevant topics” and does not have topics which can “empower students with technical and life-long skills”.

Most students and teachers suggested topics and content which they felt needed to be added or removed in order to make the curriculum more relevant to learners’ needs. However, students suggested that the introduction of philosophy, ethics, environmental education, sociology (Chimwenje et al., 1995, p. 15) would also make the curriculum more relevant for them. Although these courses are potentially empowering subjects, there was no discussion by Chimwenje et al. (1995) to this effect. Instead, they recommended that special consideration be given to the introduction of vocational subjects such as principles of accounts, commerce, carpentry, wood work, technical drawing, art and craft, brick laying and typing in the secondary curriculum.

Some of the findings of the survey contradicted the typical context of Malawian schools. None of the teachers surveyed acknowledged that students performed poorly in school subjects when, as shown in Figures 2.1 and 2.2 previously, many students do not obtain their certificates. Most of them, especially the Form 4s, do not pass mathematics.

It appears that although the survey was supposed to survey students’, teachers’, parents’ and employers’ views about the aspects of the curriculum which did not meet the needs of students, by giving preferential consideration to vocational goals, the survey represented the interests of some influential institutions rather
than the general thinking of Malawians. This is reflected in the emphasis placed on the introduction of vocational courses throughout the needs survey report. There was no discussion about the processes of learning and the way resources are used in classrooms.

2.3.2 The secondary school curriculum review symposium

Following the recommendations of the secondary school curriculum needs assessment survey, the Ministry of Education organised a national symposium in 1995 to consider a review of the curriculum. In the history of education in Malawi, this was the first deliberate and planned attempt to review the curriculum. The symposium was attended by more than 200 participants, consisting mostly of Ministry of Education officials, secondary school teachers and teacher educators. These included representatives from non-government organisations, village chiefs and political parties (Ministry of Education & Malawi Institute of Education, 1995, pp. 37-41). However, there were no teachers from Distance Education Centres, yet these constitute the majority of teachers in the secondary education system in Malawi.

The review was initiated following recommendations from the needs assessment survey that the current secondary school curriculum in Malawi does not offer the kind of education best suited to the needs of its society. In particular, Hauya (1996) noted that the current curriculum was based on the “academic-elitist tradition of education inherited from the colonial educators”. It is also examination-oriented and is geared towards “university preparation and white-collar jobs with undue emphasis on cognitive development at the expense of social skills, cultural and technological literacy” (p. 2).

The national symposium for the curriculum review had the following extensive objectives. These were to:

- discuss and identify shortcomings in the secondary school curriculum;
- formulate goals for secondary education in Malawi;
- outline the knowledge and skills ... that students are expected to acquire at the end of their secondary education programs;
- analyse issues and problems that impinge upon the delivery of quality secondary education in Malawi (e.g. resources, structural and organisational matters);
- propose alternative solutions to the issues and problems impinging on the delivery of quality secondary education in the country, for example, the development, production, procurement and distribution of instructional materials;
- present alternative strategies for upgrading teachers’ qualifications and for updating their knowledge and skills;
• articulate strategies for teacher, student and parent/community participation in decision making at the instructional level; and
• propose for adoption alternative assessment procedures to accompany the revised curriculum. (Ministry of Education & Malawi Institute of Education, 1995, p. 1)

The above objectives indicate the commitment of the curriculum review to issues regarding the quality of secondary education, teaching and learning resources and teacher development. However, these were somewhat narrow, outcome based, and materially oriented. The participants of the symposium concluded that the present secondary curriculum had the following shortfalls:

• poor correlation between curriculum and national goals of education;
• it is overcrowded, examination-oriented, academic and full of overlap of content across subjects;
• lack of teaching syllabuses;
• inadequate supervision of teachers;
• shortage of teaching-learning materials, forcing teachers to lecture, and pupils getting few opportunities for hands-on experiences;
• lack of in-service training for teachers;
• affective domains are currently neglected both during instruction and assessment. (Ministry of Education & Malawi Institute of Education, 1995, pp. 2, 3, 6, 8)

The symposium discussed the above shortfalls in the secondary school curriculum and recommended that goals for secondary education should include the following:

• the development of creativity and resourcefulness. There must be room in our teaching for originality... Pupils must be encouraged to come up with their own ideas of doing things;
• the incultation and development of problem-solving techniques; and
• the development and encouragement in the learner of the ability to synthesise and analyse data, the spirit of inquiry, independent thinking and learning. (Ministry of Education & Malawi Institute of Education, 1995, pp. 20, 21, 22)

The symposium recommended that "in-service training programs should be intensified in order to update teachers with new knowledge, skills and innovations in their respective areas" (p. 34). It also advised that the Malawi National Examinations Board should consider administering only one external examination during the secondary school cycle. The introduction of continuous assessment as a component of the final external assessment at the end of secondary education was also considered (Ministry of Education & Malawi Institute of Education, 1995, p. 36). However, some delegates expressed concerns about the reliability of this type of assessment and advised that teachers would
need the Ministry’s guidance on how to carry out continuous assessment since most teachers use questions from past examinations.

The above review indicates that the Malawi government is committed to the provision of a higher quality secondary education. This can be seen from the proposed goals of secondary education, such as the development in the learner of problem-solving skills, the spirit of inquiry, and independent thinking and learning. These goals represent a shift from approaches which are teacher-directed to approaches in which learners take more control and responsibility for learning. However, various curriculum specialists have argued that efforts to improve the quality of education need to take into account the teaching and learning problems that exist in the system. Although these were acknowledged by the symposium, the discussions lacked a detailed analysis of the enormous problems confronting students and teachers in typical classrooms in Malawi. The national symposium pointed out some of the problems confronting learning and teaching in Malawi and proposed some solutions to them. Most of these proposals were made for the attention of government. For example, the symposium recommended that the Malawi government should improve the funding of secondary education including Distance Education Centres to ensure availability of adequate teaching and learning materials. It was also recommended that government should establish new secondary teacher training colleges (Ministry of Education & Malawi Institute of Education, 1995, p. 33).

The symposium proposed that:

- teachers should develop their own teaching notes and that the notes should be shared with others;
- in-service training programs at national, regional, district and school levels should be intensified in order to update teachers with new knowledge, skills and innovations in their respective areas; and
- curriculum decision making should be participatory in nature by involving teachers, parents, employing organisations, technocrats, students and other stakeholders. (pp. 33 – 34)

The above recommendations suggest that the teachers will be required to take more responsibility for their own professional development. It is not clear how teachers will need to organise their teaching so that it enables students to be creative and effective problem solvers. The prevailing situation in Malawian schools is that students expect the teacher to show them how to solve problems. Students mostly rely on the teachers’ notes and examples. It is clear that in order to develop creativity and problem-solving skills in learners, teachers will need to draw on a wide range of resources apart from textbooks.
The symposium was organised after the Ministry of Education realised the unsuitability of the current secondary education. This observation was also supported by the curriculum needs assessment survey (Chimwenje et al., 1995). However, the approach taken by this curriculum review was largely top-down. This is because both the needs assessment survey and the curriculum review were commissioned by the Malawi government. These did not involve any qualitative examination of the practical realities of students and teachers in Malawian classrooms. Consequently, the ideas in the review mostly reflected the thinking of a few “top” minds rather than reflecting the thinking of the majority of Malawians, especially students and teachers from the Distance Education Centres who seem not to have been invited to participate in the curriculum survey and review process. As (Bishop, 1990a) comments in his reviews of Everybody Counts (Mathematical Sciences Education Board, 1989) and the Curriculum and Evaluation Standards for School Mathematics (National Council of Teachers of Mathematics, 1989), arguments for curriculum change are mostly designed to appeal to the politicians’ interests rather than to consider classroom realities.

The arguments rest more on basic and usually unexamined political tenets than on an understanding of educational realities ... [I]t is an argument designed more for its appeal to the politician’s and the business chief’s memo-writer than for its ability to convince the rest of the education profession .... It is concerned with policy, with persuasion, and with power. It is written by an influential body and it is intended to be read by other influential bodies: policymakers, industrial leaders, politicians, and people with local educational influence. (Bishop, 1990a, p. 358)

The symposium did not address the qualitative educational realities of large classes in Malawian schools. By highlighting resources as the main problem, it appears to have stuck with the “production-function” approach to educational improvement (Fuller & Clarke, 1994). The larger question of how teachers use the available classroom resources, and what meanings teachers and students give to them, was not addressed.

2.3.3 The secondary mathematics consultant’s report

At the end of 1995, the Ministry of Education hired a consultant to analyse the secondary school syllabus and textbooks, and to advise the Ministry on its review of the mathematics curriculum. Based on his two years experience as a visiting lecturer at the University of Malawi, James Heddens was appointed and funded by the United States Agency for International Development to provide the consultation.

Heddens (1995a) conducted interviews with a sample of 31 participants involved in mathematics in Malawi. These included 5 mathematics educators, 2
secondary school teachers, 2 curriculum developers and 8 secondary students. No students and teachers from Distance Education Centres were interviewed.

The participants were asked some of the following questions:

What would the best secondary school curriculum for Malawi look like? Should all secondary school students be required to study mathematics? Mathematics for all or mathematics limited to some? ... What should be the mathematics content of the secondary school mathematics curriculum? How should mathematics be taught — what methods? What should be the goals of mathematics instruction at the secondary school level? How should the examination program be related to the secondary mathematics curriculum? (Heddens, 1995b, p. 4)

In his analysis of secondary school mathematics textbooks used in Malawi, Heddens (1995b) concluded that a lot of review material is presented. He also noted that more than 60% of the textbooks contain algebra and geometry. Heddens (1995b) questioned why logarithms and antilogarithms were still being taught in Malawi when most of the world no longer have this content in their secondary school mathematics curricula. He commented that with the emerging technologies, teaching logarithms and antilogarithms is archaic. Heddens (1995b, p. 4) advised the Malawian secondary school mathematics curriculum panel to consider what the goals and purposes for the secondary school mathematics curriculum of Malawi should be; how the secondary school mathematics curriculum should be taught; and to consider the theories of learning that would be most beneficial for Malawian students and suggested that the latest theories of learning need to be given serious consideration in Malawi. Heddens further advised that

the mathematics theorists of today are advocating a constructivist theory of learning. Which simply is stating that the mathematics student must have mathematical experiences from which he/she can construct mathematics concepts in his/her own brain (see references in the bibliography). (Heddens, 1995a, p. 8)

While Heddens (1995a) rejected behaviourist approaches in teaching (p. 7), he did not provide any indications as to how he envisaged constructivist learning theories might be applied in Malawian classrooms. Heddens (1995a) cited the theories of Bruner and Piaget and simply provided a list of references, mostly about constructivism, an indication that he considered it important that the Malawi secondary mathematics curriculum review panel consider constructivist approaches to mathematics learning.

By analysing mathematics textbooks used in secondary schools in Malawi, Heddens (1995b) provided some understanding of the content in textbooks. He noted that statistical concepts only received limited attention while many countries in the world have increased the amount of statistics in their
mathematics curricula. He remarked that “understanding real life situations has become more dependent upon statistics” (p. 4).

An analysis of textbooks is important, especially as they are considered to be a key resource in education systems in developing countries.

Textbooks constitute the base of school knowledge, particularly in third world countries where there is a chronic shortage of qualified teachers. In many instances, teachers adhere closely to texts, using them as the sole source of school knowledge, assigning students lessons contained in the text and testing students only on the knowledge contained in the texts. [Yet] most third world countries have been so immersed in the problems of providing schooling to children ... that they have paid little attention to curriculum development and even less to the content of school textbooks (Altbach & Kelly, 1988, pp. 3, 10)

However, Heddens did not attempt to analyse any of the mathematics booklets in Distance Education Centres which are supposed to be used by the majority of students in the secondary school system in Malawi. Instead, Heddens (1995b) only analysed textbooks used by a small proportion of students in secondary schools. In addition, no consideration was given to the meanings of the content in textbooks. Apart from merely claiming that school mathematics in Malawi is "devoid of everyday life" (Heddens, 1995a, p. 6), no attempt was made to consider many instances in mathematics textbooks in Malawi in which the image of mathematics and the connections between mathematics and everyday life are not useful, inappropriate, incorrect, distorted and inadequately addressed. In one mathematics booklet, the study of algebra is introduced as follows:

In algebra, letters are used to represent numbers that we do not know. For example, you can change 5 pigs to 5p. When you add things like bananas, you can shorten the word bananas to a letter “b”. (Malawi College of Distance Education, 1986, p. 15, emphasis in original)

In a section titled “Using algebra in everyday life”, students are asked to consider the following example designed to illustrate that “algebra can be used to figure out many everyday activities”:

If it takes you two hours to walk to the market at a speed of 4 km/hr, how far is the market from your house?

First put the words into symbols.

\[ v = \text{km per hour} \] (speed you walk to the market)

\[ t = 2 \text{ hours} \] (time to walk to the market)

\[ s = \text{distance from your house to the market.} \]

So to find out how far the market is from your house you would put the facts into an equation (a statement making two quantities equal). The solution of this equation is as follows:

\[ s = t \times v \]

\[ s = 4 \text{ km} \times 2 \]
s = 8 km. (Malawi College of Distance Education, 1986, p. 31, emphasis in original)

In the same booklet, students are asked to note the following in an introduction to the topic directed numbers:

You should always wash your hands before you eat a meal. The water you use to wash your hands with will either be cold or warm. It is not easy to tell exactly how cold or hot something is by simply touching it. You can tell exactly how cold or hot something is, such as water, by means of temperature. Temperature is a measurement of exactly how cold or hot something is .... Directed numbers are numbers that show direction. A thermometer is an example of an object that shows direction. [It] shows both positive and negative values. (Malawi College of Distance Education, 1986, pp. 17, 28)

The introduction to a section titled “Everyday use of Pythagoras theorem” in a Form 2 secondary school mathematics textbook reads as follows:

So far the exercises in this chapter have been arranged so that when a square root of a number was needed, it could be found exactly. However, this does not happen with numbers in everyday situations. More often we have to find squares and square roots from tables. (Gunsaru, 1991, p. 82)

In the above situations, it is clear that students are being advised that their informal ways of calculating everyday quantities are inferior, illegitimate, not useful and invalid ways of reasoning in school mathematics. They are asked to ignore their own feelings and to assume scientific views of reality and formal mathematical procedures and formulae. These views about learning seem to be supported by official statements about the aims of education in Malawi. In an attempt to clarify the reasons why the Malawi secondary school curriculum needed to be changed, a Ministry of Education official stated that the curriculum needed to address the “increasingly pressing needs” of the Malawian society and emphasised that the curriculum should “select the best from our Malawian culture and the culture of other countries” (Malawi Institute of Education, 1997, p. 148). The official remarked that “it is important that our students are well informed and exposed to the theories of democratic culture as practised in the western world” (p. 148).

Without any discussion of the type of theories being implied in the above comments, together with Heddens’ (1995a) reference to constructivism and the meanings of mathematical content in textbooks, the curriculum review being proposed in Malawi might lead to a secondary education which is inappropriate and in conflict with the educational realities of most Malawian students. This point has also been raised by many educators and researchers such as Scheurich and Young (1997), Valero and Vithal (1998), and Vithal (1998) concerning the
problem of using educational theories developed in western contexts to develop and engage in educational discourses in developing countries.

2.3.4 Mathematics curriculum development workshop

In 1997, the Malawi secondary school mathematics curriculum panel, consisting mostly of practising secondary school teachers, participated in a one-week mathematics curriculum development workshop. This was the first time that mathematics teachers in Malawi participated in a school curriculum review. At the opening of this workshop, a Ministry of Education official observed that

This is an important ceremony because it will publicise one of the major activities being undertaken by my ministry in order to continue improving education in this country. In the past, there has been very little publicity of matters related to curriculum development. (Malawi Institute of Education, 1997, p. 147)

According to the official, involving practising teachers in the curriculum development process was important because teachers are much “closer to reality than university done, school methods advisors and college lecturers” (Malawi Institute of Education, 1997, p. 150). The aim behind using more practitioners was to empower teachers in the curriculum review process and to “bridge the gap between theory and practice” (p. 150).

According to the mathematics curriculum development workshop report, the participants recommended that mathematics should be taught at secondary school because it develops “problem solving ability, logical thinking and equips students with analytical skills which are important to individuals, society and academic world” (Malawi Institute of Education, 1997, p. 65). The participants noted that once individuals gained mathematical knowledge they would be more productive to the nation. This would help society to develop technologically faster (p. 65).

The panel proposed eleven objectives for secondary mathematics learning, that is, learners should be able to:

- apply maths in other subject areas;
- apply maths to solve everyday life problems;
- formulate maths problems from everyday situations;
- manipulate statistical data;
- make estimations of numerical values on calculations and measurements;
- manipulate geometrical objects in 2 and 3 dimensions;
- explain the History of mathematics in Malawi;
- perform algebraic manipulations;
- construct geometrical figures in the plan;
• discuss mathematics; and
• use trigonometrical functions and ratios. (Malawi Institute of Education, 1997, p. 65)

While the curriculum review placed emphasis on developing a curriculum that catered for the needs of the Malawian society, the extent to which the above "objectives" for learning mathematics reflect this concern is questionable. It is clear that the above objectives such as students' abilities to "manipulate" statistical data, "manipulate" geometrical objects, and perform algebraic "manipulations" only address mathematical computational aims. The reasons why these computations and manipulations are important are not discussed in the report.

Objectives such as the need for students to use mathematics to solve everyday life problems, to formulate mathematics problems from everyday situations, and to explain the history of mathematics in Malawi have the potential to address the students' everyday needs in the Malawian society. However, no detailed discussions were made on how these objectives could be achieved. There was also no indication in the curriculum development workshop report as to whether the mathematics curriculum panel discussed the recommendations from Hoddens' (1995a) consultancy report described above.

Nevertheless, the fact that the panel discussed some goals for mathematics learning is an important outcome. This is due to the fact that, since the introduction of secondary education in Malawi in 1940, mathematics teaching in schools proceeded without any explicit statement of goals (Ministry of Education & Malawi Institute of Education, 1995, p. 2). It has relied heavily on examination syllabuses which provided a list of theorems and computations which "candidates" needed to know and perform (see, for example, Malawi National Examinations Board, 1989, pp. 93–107).

### 2.4 Implications for the current study

The above discussion has revealed that recent developments in secondary education in Malawi have addressed the need to democratise curriculum and schooling processes. The Malawi government is making attempts to review the secondary curriculum so that it ensures access for more Malawians. By embarking on the development of a curriculum designed to cater for the needs of the current Malawian society, the government of Malawi is addressing issues of quality secondary education in general and mathematics education in particular. These developments are consonant with developments in education in many other developing countries. For example, referring to the current changes in the school
curriculum in South Africa, Bopape and Volmink (1998) have reported the efforts of educators to reposition mathematics as a “people's subject, a subject that relates to the context in which people find themselves, a subject that enables people to see and question the unjust” (p. 78). The aim is to strive for a mathematics education that meets the needs of “the large numbers of the people who voted democracy in during the 1994 elections” (p. 78). Bopape and Volmink’s comments tie quite strongly with developments in secondary education in Malawi, which aim to develop an education that is sensitive to the needs of the majority of Malawian students who have, for more than thirty years during the one-party regime, experienced a culturally and politically insensitive mathematics curriculum. However, as indicated earlier, developments in mathematics education in Malawi have not been supported by any empirical and epistemological justifications for achieving an education that connects school mathematics to students’ needs and everyday lives. The democratisation of the Malawian society has provided favourable conditions for developing mathematics education in line with people’s needs and realities. However, as Gerdes (1985) explains, “democratisation is a necessary but not sufficient condition for mathematics education to become really emancipatory — everyone mastering mathematics and capable of thinking mathematically, to the benefit of society as a whole” (p. 15, emphasis in original). There is a need to problematise reality, to discuss mathematics education, its aims and purposes and elaborate on effective ways of teaching mathematics and enhancing its values.

The above considerations have critical implications for changing mathematics education in Malawi and hence for this study.
CHAPTER 3
A CONCEPTUAL FRAMEWORK FOR CONNECTING EVERYDAY EXPERIENCES AND MATHEMATICS LEARNING AND TEACHING

The relationship between school mathematics and the social, cultural and political context has been a focus for discussion in mathematics education internationally for many years (see, for example, Damerow, Dunkley, Nebres & Werry, 1984; Keitel, Damerow, Bishop & Gerdes, 1989; Atweh, Kanes, Carss & Booker, 1993; Davis & Maher, 1993; Julie, Angelis & Davis, 1993; Bishop, Clements, Keitel, Kilpatrick & Laborde, 1996; Gates, 1998; Watson, 1998). Focusing on the role of context and everyday reality in learning has given a different and more practical dimension to mathematics learning and teaching from that assumed in traditional classrooms. Discussions on the role of context have placed varying degrees of emphasis on changing mathematics learning, revitalisation of the discipline of mathematics and democratisation of schooling processes.

These discussions have been a reaction to widespread poor performance in school mathematics across different ages of students. They have also been a reaction to the widespread public image of mathematics as difficult, abstract, boring, oppressive, but undoubtedly important. These discussions have questioned the nature of mathematics. Rather than assume it as objective, absolute, and value-free knowledge, mathematics is proposed to be a contestable, fallible, changing and human activity (Ernest, 1991). This is because mathematics is associated with sets of social practices, each with its history, persons, institutions, symbolic forms, purposes and power relations. The discussions have reconceptualised mathematics as a “living body” — not a skeleton — as evidenced by its widespread and critical usage in society (D’Ambrosio, 1990; Ernest, 1991; Rogerson, 1986; Restivo, 1994).

In this chapter, I examine specific perspectives in mathematics education which have advocated the use of everyday experiences as a vehicle for changing mathematics learning and teaching. I discuss various ways in which mathematics educators have attempted to theorise about and practically connect everyday experiences and school mathematics learning. Firstly, I establish a framework for learning and the context in which this might be conceptualised to take place, taking into account the practical context in which this study is located. Secondly, I review and discuss various perspectives which have been used in connecting
school mathematics learning and everyday experiences. In doing this, I
demonstrate that these perspectives have been a departure from common
tendencies to involve students in solving word problems which are assumed to
connect mathematics and the real world. Four perspectives are reviewed which
are seen as departure points from the uncritical use of word problems. These are:
the use of mathematics applications, modelling and real-world problem solving;
situated cognition; Realistic Mathematics Education; and critical mathematics
education. In discussing these perspectives, the aim is not to privilege,
underestimate or reject any of these without any contextual justification. Rather,
it is to demonstrate that these perspectives build on each other in various ways.
For example, while the ways in which applications and modelling activities have
been conceptualised and reported show a lack of consistent analyses of
mathematics applications, situated cognition, Realistic Mathematics Education
and critical mathematics education have some clear ontological and
epistemological views on mathematics applications. However, the situated
cognition perspective lacks a consistent commitment to formal mathematical
knowledge, while Realistic Mathematics Education and critical mathematics
education have explicit emphases on the formalisation of mathematical
knowledge from everyday reality. Critical mathematics education, however,
takes a broader view of learning and mathematical knowledge than the other
perspectives.

The aim here will be to discuss the literature, examining it for the possibilities and
constraints for adapting their use in the teaching and learning of secondary
mathematics in Malawi.

The critical mathematics education perspective is proposed and discussed as a
more appropriate framework for contextualising change in mathematics
education in Malawi. This is because critical mathematics education has a broad
view of society. It is an approach that is flexibly attuned to the political realities
schooling. It also explicitly engages with change in mathematics education.

The final section of this chapter reflects on the practical implications of using a
critically-oriented approach for changing mathematics learning and teaching in
Malawian schools. A way of situating the research study in the schools is
explored and discussed.

3.1 A framework for learning in school mathematics

We start from what the learner knows in order that he or she can
know better, know more and know what he or she does not know yet.
(Freire, D'Ambrosio & Mendonca, 1997, p. 8)
Many authors in various contexts have contributed significantly towards our understanding the term "learning" in mathematics. In recent years, research and debates about teaching and learning have departed from behaviourist arguments that typically characterised education, and mathematics education in particular, in the past. In place of behaviourism and instrumentalism, constructivism has emerged as a framework from which to view learning. In constructivism, learning is viewed as a process in which knowledge is actively constructed by the cognising subject, not passively received from the environment. Coming to know is an adaptive process that organises one's experiential world; it does not discover an independent, pre-existing world outside the mind of the knower. (Lerman, 1989, p. 211)

Constructivism describes the process of coming to know or learn something — to construct knowledge. This process has typically been understood as taking place inside the learner's mind. A radical constructivist view of this process argues that it is impossible to completely determine what is in the mind of the learner. This discussion has been widespread as can be seen in various publications (see, for example, Von Glasersfeld, 1991; Von Glaserfeld, 1995; and Lerman, 1993; Von Glasersfeld, 1990; in two special volumes on constructivism). However, the other characterisation of constructivism - social constructivism - views as problematic the notion that the process of constructing knowledge takes place in the learner's mind. Social constructivism considers the intersubjectivity of the knowing process and takes the view that meanings need to be "taken-as-shared" so that they can be made public in some way in order for learners to be able to communicate and have some discussion about the knowledge they are trying to build (Ernest, 1991).

Various interpretations of this knowledge-building process have indicated the need to consider aspects such as reality, truth, and knowledge as problematic and have insisted on knowledge construction as a process in which the learners "make sense" of their experiences. New experiences are interpreted taking into account previous experiences and knowledge of the learner and the connections between these. This "sense making" process is complex, ever changing, active, and dialectically related to a spectrum of experiences, both personal and social. This conception of learning underscores the notion that learners are considered as individuals located in a broad sociopolitical context.

An often-quoted statement related to understanding how educators attempt to change the way students learn is: "find out what the learner already knows and teach him accordingly" (Ausubel, 1968, p. 337). What learners know and can already understand includes their experiences in their everyday lives. These experiences are already familiar to the learners. There is a need to build on the
learners’ experiences in their attempts to make new meanings and connections. This familiarity of experiences facilitates the learning process.

As a way of learning, constructivism has implications for teaching. The behaviourist understanding of teaching has been that the teacher transfers his or her knowledge into the head of the learner. There is widespread consensus in the mathematics education literature that this view of teaching is problematic and counterproductive as it undervalues the learners’ abilities to personally and cooperatively engage in the process of making their own meanings. The role of the teacher is to facilitate this knowledge construction process. The teacher has subjective knowledge (not true knowledge) which is publicly shared and discussed with learners and not distributed to them.

According to Mercer (1995),

teachers are expected to help their students develop ways of talking, writing and thinking which will enable them to travel on wider intellectual journeys, understand and being understood by other members of wider communities of educational discourse: but they have to start from where learners are, to use what they already know, and help them go back and forth across the bridge from “everyday” discourse into “educated discourse”. (p. 83)

Teachers adopting a constructivist view of learning are expected to assist students to critically engage with mathematics, pose problems and make connections between school mathematics and reality. The dichotomy between teaching and learning is broken since teachers are considered as “learners”.

Through dialogue, the teacher-of-the-students and the students-of-the-teacher cease to exist and a new term emerges: teacher-student and students-teachers. The teacher is no longer merely the-one-who-teaches, but one who is himself taught in dialogue with the students, who in their turn while being taught also teach. They become jointly responsible for the process in which all grow. In this process, arguments based on “authority” are no longer valid; in order to function, authority must be on the side of freedom, not against it. Here, no one teaches another, nor is anyone self-taught. [Individuals] teach each other, mediated by the world. (Freire, 1972, p. 53, emphasis in original)

Taking a constructivist view of learning has enormous implications for teaching. Smith (1999, p. 149) argues that while understanding “what reality is like” (the ontological question) is already difficult, “how reality is known” and communicating that reality is an even more complex process. Also, teachers adopting a constructivist view of learning can no longer believe that they will communicate the “same” meanings to all learners. The classroom needs to accommodate diverse meanings. Volmink (1990) illustrates this diversity with the metaphor of art as follows:

When I visit an art museum to view the work of an abstract expressionist, it is sometimes the case that I cannot relate to the work
at all. As I stand and look at the exhibition and see other people apparently seeing deeper meaning in the work, I can interpret the situation in several ways. Firstly, I could tell myself that I am not sufficiently “cultured” to understand the work of art. In other words, I can explain my lack of appreciation in terms of a deficit model. Alternatively, I could say that art is more than what can be found in an art museum. What I cannot say, is that the work on display is not art. I can only say it does not uniquely represent art. I may also realise that often people that fund art exhibitions and museums have the power to decide what will be on display and what is not good enough and that they have the power to define art for us. However, unless I am willing to agree that art museums do not define art, I am always likely to feel deficient in one way or another. (p. 245)

The constructed meanings cannot be imposed. One’s view of knowledge or the meanings made are considered as subjective knowledge. That knowledge is regarded as just one construction and not representing universal or more preferred knowledge. The knowledge and patterns of meanings are “a result of an active and purposeful construction by [individuals] dialectically interacting with [the] world” (Volmink, 1990, p. 246).

A key aspect of this knowledge-construction process concerns the context in which learning takes place. Sierpinska and Lerman (1996) state that “since all learning is a process of constructing, students will be doing so in whatever classroom situation exists” (p. 846), “even in a formal lecture hall of 300 students” (Lerman, 1996, p. 147). Without a specification of the practical context in which learning takes place, these statements are sweeping generalisations of learning. Typically, constructing knowledge cooperatively, through dialogue, negotiation and sharing through small group work are considered to be highly desirable elements of a constructivist classroom. However, in the real world, when the teacher may be faced with 200 students, for example, how will this teacher come to know more and build on what learners already know?

In the authoritarian case, as Cobb (1994a, p. 4) has elaborated, students will still be learning something, but, as Wenger (1998, p. 40) has clarified, they will possibly be learning more about how not to learn, to cope with the learning situation rather than constructing mathematical knowledge per se. In a situation where the teacher does not have access to meaningful tools for facilitating learning, the teacher will possibly be more preoccupied with learning how to build a “pedagogic space” (not an environment as it is conventionally understood) that could facilitate learning. The extent to which the teacher builds that space together with students depends on the broad context of learning some of which might be beyond the teacher’s “management” capacities.
In all these situations, according to constructivism, learners will still be constructing their own knowledge. The extent to which this knowledge leads to building a deeper and broader understanding of and knowledge about mathematics, a key outcome that most current teaching aims to achieve, depends on many factors such as the contexts and goals of mathematics education. Cobb (1994b) called for educators to account for learning as it occurs in social and cultural contexts — to understand learning from various perspectives depending on the problems and issues at hand. When this argument is contextualised and recontextualised to take into account the political aspects associated with learning, it is a broad framework to adopt in an attempt to connect everyday experiences and school mathematics learning and to theorise this connection.

3.2 “Earlier” perspectives on connecting school mathematics learning and everyday experiences

In this section, I discuss the need for school mathematics to use a broader framework for connecting everyday experiences and school mathematics learning than merely using “word problems”. I consider the use of mathematics applications, modelling and real-world problem solving as a broader way than the use of word problems for conceptualising links between everyday experiences and school mathematics. I then explore the implications of using mathematics applications, modelling and real-world problem solving for classroom practice.

3.2.1 Word problems

Word problems have traditionally been used as a way of connecting school mathematics and everyday experiences. Typically, mathematics content is taught first, and “real-world” applications are presented in exercises later. In this way, students are expected to apply newly acquired mathematical skills to problems which are supposedly “real”. Often, there is little attempt to link the “real world” applications with students’ own real world. Students are there to practise mathematical techniques in “dubious” questions (Burkhardt, 1983, p. 228). The origins of the underlying concepts and ideas in these questions remain unclear and hidden and possibly only vaguely understood by the teacher (Bishop, 1990b).

Ascher and D’Ambrosio (1994) cite an example from linear programming in which the task is to minimise some function under linear constraints.

One ... application was the creation of a diet for pigs. The constraining equations were their daily nutrient requirements and then, using current prices, the most economical diet was found. But the pigs wouldn’t eat it! There are a number of similar examples where the mathematics was absolutely correct but the solutions
couldn’t be used because the audiences and their tastes were ignored during the mathematical formulation. (p. 40)

Ascher and D’Ambrosio (1994) point out that using superficially real problems is one of the causes of the dislike of mathematics among learners. It creates a long term feeling often articulated by those alienated to mathematics, that it is “emotionless and lacks feeling” (p. 40). Students who like mathematics also often lack a deeper understanding that relates mathematics to reality and humanity.

The above example raises the question of what constitutes everyday experiences, and whether everyday experiences have any educational value (Floden, Buchmann & Schwille, 1987; Sierpinska, 1995). Questions have also been asked about the role of contexts in the mathematics classroom, particularly regarding the extent to which contexts make mathematics more “real” (Boaler, 1993; Masingila, 1993). Boaler (1993) asks the question “How real is real”? (p. 14). In other words, at what point do we consider a real situation (problem) to be really real (or about actual reality)? Additionally, questions such as “whose reality?” or “whose everyday experience?” need to be addressed. In answer to the question “how real is real?”, Boaler (1993) cites an example of a classroom investigation in which students were asked to

imagine a city with streets forming a square grid where police can see anyone within 100m of them; each policeman being able to watch 400m of street. Students are required to work out the minimum number of police needed for different-sized grids. (p. 14).

Boaler argues that this task asks students to “enter into a fantasy world in which all policemen see discrete units of 100m” (p. 14), and see no more or less.

Quoting Schoenfeld (1987), Boaler (1993) reports a question in which students were asked to calculate the number of buses needed to carry 1128 soldiers, if each bus carries 36 people. Most students gave an answer of “31 remainder 12”. According to Boaler (1993), the contexts in which these problems are asked are “intended to give mathematics a real life dimension”, when in fact some students do not give answers which reflect the intended reality. However, these problems have little connection with students’ experiences in real life. They are best described as “school problems coated with a veneer of ‘real world’ associations” (Schoenfeld, 1987, p. 37). Most mathematics word problems in school textbooks have cooked-up data or numbers arbitrarily given for question items covering a narrow range of real-life aspects such as money, time, mass, area, volume and distances. The problems will use words from daily existence or other disciplines, but it will be quite clear that no real application is intended (de Lange, 1996). As de Lange (1992) has explained, the contexts in problems similar to the above situation merely “camouflage” or “dress up” the mathematical problems. They
are only word problems, exercises, and nothing more. Pollak (1968) best captures the dilemma of using "word problems" as follows:

Some people seem to have the idea that just using the vocabulary of another discipline in a mathematical problem will motivate and excite a student who is interested in applying mathematics to this other discipline. The theory appears to be that it is not necessary to understand where the mathematical formulation of the problem comes from, or to understand what has been kept and what has been thrown away, or even to understand what the words and the symbols mean. Just use a physical vocabulary, for example, and every prospective physicist will be happy ... If you look at typical textbooks that try to give such "applications", ... the caricature comes all too close to the truth. (pp. 24–25)

Pollak (1968) further argues that students, as well as teachers, often have very limited knowledge about any field of application. They use word problems without much thought about their real-world context.

The implication of the above discussion is that it is not sufficient to give students word or story problems. Such problems may have very little connection with everyday experiences. They do not change the way students approach solving mathematics problems, nor do they encourage them to develop a more humanistic and meaningfully connected view of mathematics.

### 3.2.2 Mathematics applications, modelling and real-world problem solving

As a departure from using "bare sums" or "word problems", there have been many formalised attempts in the past three to four decades to connect school mathematics and everyday experiences. These have appeared in various versions such as applications, mathematical modelling and real-world problem solving (see, for example, Pollak, 1979; Bell, 1983; Niss, 1987; Blum & Niss, 1991). These attempts have been communicated in various mathematics education conferences such as the International Congress on Mathematical Education (ICME) and the International Conference on the Teaching of Mathematical Modelling and Applications (ICTMA). These have also been documented in various research publications, textbooks and programs, collections of case studies, and teaching and learning resources of various types at various school levels.

According to Bell (1983) and Niss (1987), these attempts have been made in various parts of the world, although a number of authors have pointed out the difficulty of accessing publications and reports on mathematics applications from some countries due to language problems and the non-existence of official publications in these countries (Blum, 1993). However, Niss (1987) points out that in countries with centralised curricula, the development and inclusion of
"proper" applications on a large-scale have generally not been very successful (p. 499). In addition, Niss comments that in developing countries, the emphasis on applications has been in primary school curricula, while emphasis at the secondary school level only exists in principle. At the secondary and tertiary levels, Niss claims that there is more preoccupation with providing people with a general educational background to enable them to facilitate leadership and development of their countries than with an emphasis on applications of mathematics. However, Niss (1987) noted that the situation was changing. As will be discussed in Section 3.3.3, mathematics educators in developing countries are addressing the need for mathematics to be made more relevant to the everyday realities of students at different school levels.

The publications and resource materials on mathematical applications, modelling and real-world problem solving, that have been widely available and reported, have generally been from developed countries such as the USA, the Netherlands, the UK, Australia and Germany. These materials and resources, individually initiated or project based, have been comprehensively reported in Bell (1983, pp. 256–267) Blum and Niss (1991, pp. 55–57), and Blum (1993, pp. 8–11), among others. They include the following:

- From the USA: The "High School Mathematics and its Applications Project", which provides modules for secondary mathematics teaching (Malkevitch, 1985); The "University of Chicago School Mathematics Project" — which develops and provides courses with real-world applications for primary and secondary school mathematics (Usiskin, 1989); the "School Mathematics Study Group" — which provides a collection of problem sets for teachers built around a theme and responding to mathematical demands mainly from arithmetic (Bell, 1972); the "Unified Sciences and Mathematics for Elementary Schools" Project in which children participate in solving "real" problems identified from their own situations. The solutions are intended to result in some form of action on the "real" problems (Gilbert, 1974).

- From the UK: Several projects directed by Burkhardt and Fraser and others. These include the "Numeracy through Problem Solving Project" for the lower secondary school level (Binns et al. 1989); the "Mathematics and Applications Project" — which provides textbooks and resource materials for teachers with a focus on mathematical modelling (Ornell, 1982); the "Spode Group" which provides A-Level courses for 16-18 year-olds, the courses cover topics and contain examples of examination questions with details of support materials (The Spode Group, 1989).
• From Australia: The "Practical Applications of Mathematics" project which published two booklets with detailed examples and teaching units for lower secondary level, covering a broad range of fields of applications; The "Mathematics In Society Project" — an international project based in Australia which involves teachers in the development of materials for use at the primary and secondary school levels (Rogerson, 1982); the "Reality in Mathematics Education" project (Education Department of Victoria, 1984); the "Mathematics Curriculum and Teaching Program" which published two volumes of student activities for the secondary level (Lovitt & Clarke, 1992); two volumes by Lowe (1988), with activities emphasising investigations and modelling of real-world situations and using the computer as a tool.

• From the Netherlands: Several materials and booklets developed by the Freudenthal Institute (formerly known as OW&OC). These include materials by the "Wiskobas" project at the primary level (Treffers, 1993), and materials developed by the HEWET project for upper secondary level (de Lange, 1987). The materials are organised according to mathematics topics with modelling examples designed to support student learning. A recent project has also been initiated by the Institute for Curriculum Development (SLO) which attends to the needs of slow learners and the importance of linking mathematics to the future workplace of these learners (Van der Zwaart, 1997).

There are also several examples of materials from Germany (see, for example, Volk, 1989) and other countries (see Bell, 1983, for a detailed listing). However, the majority of the projects are from developed countries. Some of the few from developing countries which are reported in Bell (1983) include the "Matematica Aplicada" project from Brazil, which presents a mathematics course designed to bring mathematics "closer to reality" and to be shown to be more useful for the majority of students who frequent Brazilian schools (Bell, 1983, p. 264).

The arguments for using mathematics applications, modelling and real-world problem solving have generally been a response to the demand to make mathematics more useful and meaningful for students. There have also been arguments about enabling students to mathematise, that is, to build mathematical models from real-life situations. These pedagogical arguments have generally been in the line of sequencing — that is, whether to teach so that mathematics is seen as useful at the beginning or at the end of a lesson or unit, or integrated throughout lesson units. I briefly review these arguments drawing on Niss (1987) who has described three ways in which mathematics applications, modelling and real-world problem solving are used.
According to Niss (1987), the first way is best described by the slogan
"Mathematics can be used to do so many things in so many areas; let us show
you some of them" (p. 497). This argument has been a reaction to the widespread
demand for mathematics teaching to illustrate the usefulness of mathematics. This
demand has been reflected in the increasing bank of "examples from which
teachers, textbook writers and educationalists could gain inspiration and draw
material" (p. 495). The actual classroom presentation of these applications have
been regarded as separate topics in the syllabus, with closed questions demanding
straightforward answers. The use of the term "model" has only been used when a
distinction between "reality" and "non-reality" is being made.

Freudenthal (1968) has argued that teaching mathematics with "no other relation
to its use than hope that students will be able to apply it whenever they need to"
has been largely unsuccessful.

The huge majority of students are not able to apply their
mathematical classroom experiences, neither in the physics or
chemistry school laboratory nor in the most trivial situations of daily
life. (p. 5)

Some arguments have been made to teach useful mathematics. However, as
Freudenthal (1968, p. 5) has emphasised, teaching useful mathematics has little
impact and only proves "useful as long as the context does not change" (p. 5). A
common alternative to this has been to deliberately ignore the context and to
"put [the useful mathematics] into a mathematical form in which it can be used
time and again" (p. 5). However, Freudenthal (1968) has argued that "teaching
pure mathematics and afterwards [showing] how to apply it" is still not
appropriate as it is the "wrong order" (p. 5).

The second way in which real-world applications have been used is characterised
by a need to allow students to "mathematise", that is, to build mathematical
models related to situations and to "acquire [an] ability to activate mathematics
themselves in dealing with problems and situations of other disciplines and from
the world surrounding them" (Niss, 1987, p. 495, emphasis in original). These
problem situations are open-ended but accessible to students' own influence.
However, they are mostly intended to lead students to build less sophisticated
models. Typically, students are not presented with these models as "objects of
learning", but to allow students to develop the models on their own efforts (Niss,
1987, p. 496).

The argument for mathematisation stems from the belief that "mathematics
means mathematising reality" (Freudenthal, 1968, p. 7). There are claims that

Arithmetic and geometry have sprung from mathematising part of
reality. But soon, at least from the Greek antiquity onwards,
mathematics itself has become the object of mathematising. Arranging
and rearranging the subject matter, turning definitions into theorems and theorems into definitions, looking for more general approaches from which all can be derived by specialisation, unifying several theories into one. (p. 6)

Freudenthal claims that this mathematising aspect of mathematics has been a most fruitful activity of the mathematician. He argues that students are undoubtedly entitled to enjoy this activity because "modern mathematics is both much more flexible and much simpler than the mathematics of fifty years ago" (p. 6). In this way, it is believed that teaching mathematics bridges or repairs the "gap" between "school mathematics" and "grown-up mathematics". This argument has also been based on the understanding that mathematics, in itself — without connecting it to everyday experiences — can still be made more meaningful by showing connections between different mathematical concepts and ideas. This is also to acknowledge that mathematics is often considered an object, a reality of its own, and an experience.

This mathematising aspect typifies the many mathematics resource materials under the label of "mathematical applications and modelling". For example, Lowe (1988) gives the following introductory remarks to students in his first volume entitled Mathematics at work: Modelling your world:

Are you one of those people who thinks maths is dull? It doesn't have to be, you know. If you have been bored, maybe the maths you were doing has been too abstract, it might have been hard to understand, and maybe you had to practise some skills to death for no obvious reason. This book has a lot of ... things for you to do: ... investigations ... These are much more fun to do ... My goal in writing this book is that you will grow in ability and confidence to use mathematics outside the classroom ... so that the experience of doing real mathematics is one that you will want to repeat. Good modelling.
(p. viii, emphasis added)

However, according to Niss (1987), the main direction of these modelling processes and applications is still "from mathematics to applications" (p. 496, emphasis in original), with the mathematical activities and processes being controlled and generally known to the teachers.

The third way is characterised as a reversal of the above. In this case, the "field of applications and the problems associated with it [come] first" (Niss, 1987, p. 497, emphasis in original). The mathematical topics and methods to be used mostly depend on the nature and demands of the problem situation. Mathematics is taught mostly as a tool to use in understanding the problem situations. According to Niss (1987), in practice interest in mathematics often goes as far as "mathematics has something to contribute to [the problem situation]" (p. 497).

Bell (1983) has also made the point that the aim is to teach mathematics so that it is much more purposefully and closely linked to its actual uses. The idea is to
get rid of the “useless, the ugly, and the essentially dreary aspects of the school mathematics experience (p. 252).

This aim for mathematics teaching — to link school mathematics to its actual uses — has been emphasised time and again as described by Freudenthal (1968) who noted that “most people never succeed in putting their theoretical knowledge to practical use” (p. 4). He argued that

Since mathematics has proved indispensable for the understanding and the technological control not only of the physical world but also of the social structure, we can no longer keep silent about teaching mathematics so as to be useful. In educational philosophies of the past, mathematics often figures as the paragon of a disinterested science. No doubt it is, but we can no longer afford to stress this point if this keeps our attention off the widespread use of mathematics and the fact that mathematics is needed not by a few people, but virtually by everybody. (Freudenthal, 1968, pp. 4-5)

However, Ernest (1991) and Abraham and Bibby (1992) have argued that this justification for teaching mathematics is shaped by instrumentalist views of mathematics advanced by “industrial trainers”. The industrial trainers see the aims of mathematics to be oriented towards applying mathematics to industrial problems. They press for a curriculum which “serve[s] the perceived desires of industry within the economy” (Abraham & Bibby, 1992, p. 181).

3.2.3 Implications of using applications and real-world problem solving for classroom practice

Case studies on the effectiveness of using applications, modelling and real-world problem solving in the teaching of mathematics have been conducted in various countries and reported in various publications. Varying degrees of effectiveness have been reported. Although some successes have been reported, these have been marginally positive.

In his book Mathematics at Work, Lowe (1988) reported that some students enjoyed working in groups and researching real information from “strangers”. This gave students more confidence and responsibility for their learning. Kaiser-Messmer (1989) reported on a survey of empirical investigations into the effectiveness of applications-oriented mathematics teaching. According to Kaiser-Messmer (1989), the results of these investigations were mostly of the quantitative-statistical form, and concerned improvement in students’ attitudes to mathematics. Insights into the impact of using applications on the teaching-learning process were limited and rarely reported. However, Kaiser-Messmer’s (1989) study reported that most students improved in their abilities to “master everyday situations” in which mathematics was used. Modelling activities increased student motivation and promoted their abilities to apply mathematics
Clatworthy (1989) similarly reported that students developed positive attitudes to mathematics and confidence in personal skills such as writing and discussion skills as a result of being involved in modelling activities.

Motivation and confidence related effects on student learning of mathematics have been emphasised by many authors who have reported on the effectiveness of using applications and modelling activities in teaching mathematics. Ornell (1989) used the term “application readiness” to denote the use of applications and modelling activities in the classroom to provide students with an “optimally supportive background for learning mathematics” (p. 105). Students who have been involved in mathematical modelling processes involving real-world situations have the added advantage of using applications as additional reinforcement and motivation for learning. This “attitude”, interest and motivation aspect for students has also been extensively covered in most of the case studies in de Lange, Huntley, Keitel and Niss (1993). For example, Burrill (1993) reported that students enjoy doing mathematics, develop a facility to ask questions and summarise and interpret various real-life data. However, both Burrill (1993) and Verschaffel, de Corte and Borghart (1997) have reported that students’ interpretations often have very little reference to real situations. However, Schroeder and Shealy (1997) have reported that activities in mathematical applications challenge students and engage them in thinking critically and using mathematics more thoughtfully.

However, the impact of using applications and modelling activities in the classroom is not widespread. There are many obstacles that prevent the teaching of applications and modelling of real-world situations from having a tangible impact on classroom practice. These problems have been summarised by Bell (1983). More recently, these obstacles have been highlighted in some case studies (see, for example, Hodgson, 1997).

According to Bell (1983), the emphasis on teaching mathematics so that it is seen to be useful has had very little impact on the actual experiences of school mathematics. Bell (1983) made these conclusions after a worldwide survey of more than 65 resource materials used in teaching mathematics applications. He concluded that although these materials may be in abundant existence they have had little impact on mathematics teaching because of four obstacles. Firstly, these resources are not widely accessible to “teachers and curriculum builders who are not themselves specialists in mathematics” (p. 253). Secondly, “transforming these materials into actual school-useable problems, problem sets, or units of work... interesting to school students” is problematic (p. 253, emphasis added). Referring specifically to the materials produced in the Netherlands, Bell (1983)
points out that these may also not be readily usable in other contexts because they are in a foreign language. Thirdly, although the materials may be available and accessible in some usable form, they may not be actually used in schools unless they are “worked into the curriculum guides, examination syllabuses, and textbook materials which guide teachers in what they do with their students” (Bell, 1983, p. 253, emphasis added). This has been a major threat to the impact of applications in the school curriculum. Even when they have been worked into the school curriculum, Stacey and Groves (1989) note that

It is difficult to ensure that all teachers recognise and value the desired objectives in their students’ work. Communicating to teachers the real aims of teaching for process is extremely difficult; it is still more difficult to communicate them to parents, potential employers and students (p. 246, emphasis added)

Some recent developments in the UK indicate that applications of mathematics can be accommodated into the school curriculum with some potential success (see, for example, Gillespie, 1997). However, assessment continues to be a widespread obstacle.

The fourth obstacle, according to Bell (1983), concerns the need to actually “persuade” and “train” mathematics teachers to link mathematics to its uses. This is because teachers rarely have much feeling for mathematics itself, let alone the knowledge of its fields of applications. However, Bell also notes that some teachers succeed in linking mathematics to its uses without access to any formalised textbook resources. They rely on published raw materials and their own experience.

The overall picture is that mathematical modelling processes place heavy demands on teachers’ capacities and knowledge. Modelling activities also require much structuring of content and model-building processes. They tend to be messy, lengthy, and less predictable and may not give well-defined answers to original problem situations. As one student from de Lange’s (1989) empirical investigation has said, modelling processes make mathematics “more connected to reality” and this means that a teacher “has to be interested in society ... and not just live in the world of maths”. This stretches the limits of teaching even further.

Although connecting school mathematics to everyday experiences in the ways described above may have little impact on the learning of school mathematics, there is still a need to use everyday experiences as a tool for learning about mathematics. This need is well illustrated in the following statements:

Students are not “located” as students of mathematics, but first of all as citizens ... . Mathematics is [therefore] grasped not only as a tool for illustrating questions, problems and information [about
society], but also as a tool which can distort questions, problems and information. (Skovsmose & Nielsen, 1996, p. 1266)

Reality for a child is the natural and social environment in which [they] live, an ambience with both cultural and emotional overtones ... . In the same way as we perceive reality, we perceive knowledge, we perceive language, and we perceive arithmetic. (D'Ambrosio, 1981, p. 36)

The learner is located in his or her experiences. So education needs to be within the reach of the experiences the learner already possesses and shares as a "being-in-the-world-with-others" (Borba, 1990, p. 39). The learning process should relate to the background of the students, what students already know and are familiar with. The aim is to transform their world and everyday realities (Freire, 1972).

The use of everyday experience in teaching mathematics provides a powerful and useful means of linking mathematics to the real world of all students, including those who are least likely to succeed in school (Frankenstein, 1993; Shor, 1980).

Using everyday experiences in teaching accommodates students' experiences, the voices and histories through which they naturally give meaning to their world. Learning can be conceptualised as making connections and meaning making, and teaching as the facilitation of this meaning-making process. Starting with everyday experiences allows the learning process to progress in different directions according to the interests, needs and capabilities of each learner. The objects of the learning process are not limited to mathematical knowledge but also to other forms of knowledge, informal but legitimate in their own right, that may be of interest to the students if they feel motivated to pursue them. As Fasheh (1982) says, using cultural, societal and personal experiences has the potential of making mathematics teaching more effective and meaningful (p. 2).

Rather than focus exclusively on the applications and uses of mathematics, some recent discussions and publications concerning modelling, real-world problem solving and applications have appeared under a broader title of teaching and learning mathematics in context (see, for example, Breiteig, Huntley & Kaiser-Messmer, 1993). The aim is for the teaching, and in particular, the assessment of mathematics to accommodate the abilities of all students.

Various authors such as Galbraith (1995b) have commented that assessment needs to shape and be integrally connected to instruction. Assessment must determine not just what students do not know, but also what they do know and how they think. Examples of the type of mathematical problems involved — which recognise the need to be more "inclusive" and to accommodate students' everyday experiences and what they already know — are reflected in
developments in school mathematics assessments such as those in the Victorian Certificate of Education (see, for example, the problem titled "Walking in the rain", a two-week Common Assessment Task cited in Money, 1993, p. 170). Galbraith (1995a) argue that the Common Assessment Task approach addresses the question of "comparability" and entails a constructivist view of learning. Galbraith (1995a) argues that the "common" aspect of the Task suggests a concern for "universality" (p. 312). However, Galbraith (1995a) points out that some of the problems administered under the label of "common" assessment may not be so "common" because they do not adequately recognise that students doing these tasks may not be from the "same" or "equal" family or educational backgrounds.

In this connection, Niss (1987) has pointed out that ontological and epistemological analyses of these applications have not been extensively made. Niss has suggested the following:

If our aim is to provide students at any level with knowledge about, insight into, and sound judgement on the role of mathematics in the world ... then mathematics education must encompass [epistemological] analyses. If we go too far in preaching the gospel that mathematics is unrestrictedly applicable to any kind of problem whatsoever, we will be overstating the case. (Niss, 1987, p. 502)

Blum and Niss (1991, p. 46) have also called for the need for systematic reflections of a "philosophical [and] sociological" nature on mathematics education and the development of new curricula based on such reflections. They argue that, by and large, the research paradigms on applications, modelling and problem solving have not changed significantly. There has been continued emphasis on more dissemination and publications on applications, and arguments for their inclusion in the mathematics curriculum, rather than on intentions and values for learning.

### 3.3 Three recent perspectives on connecting school mathematics learning and everyday experiences

In recent years, mathematics educators and researchers have theorised and systematically analysed attempts to connect everyday experiences and mathematics learning from three main perspectives which overlap since they are all based on a constructivist view of learning. However, they differ in the extent to which they make explicit connections with school mathematics and the extent to which they explicitly use everyday experiences as a vehicle for changing mathematics education. Based on the current mathematics education research literature, I have labelled these as situated cognition, Realistic Mathematics Education, and critical mathematics education. In the following sections, I
describe and discuss these perspectives, examining them for their strengths, limitations and instructional implications.

3.3.1 Situated cognition: Learning in practice

I use the term situated cognition to denote a general perspective associated with the work of Lave (1988), Nunes, Schliemann and Carraher (1993) and de Abreu (1998) who have studied learning in social and cultural practices. Various labels have been used to characterise these studies, the most common being "street mathematics", "everyday mathematics", "informal or implicit mathematics", or "out-of-school mathematics". In spite of the different connotations, these studies share a common theme of studying individuals using mathematics in everyday-life practices. The aim is to connect school mathematics and the knowledge gained from studying everyday practices. These studies have made explicit reference to social activities such as candy selling, shopping, and dressmaking that shape the use of mathematics in everyday lives.

The situated cognition perspective considers everyday mathematics as a legitimate body of mathematical knowledge and practices that individuals have accumulated through their participation in (everyday) activity (Brown, Collins & Duguid, 1989). It is a perspective that sees knowledge as context dependent, that is, "the nature of a person’s knowledge of mathematics is inextricably tied to the situations in which that knowledge was acquired" (Putman et al., 1990, p. 94). The meanings of that knowledge are derived from the conditions and activities which produced that knowledge. This perspective is at odds with some current traditions in mathematics education where goals and outcomes of the curriculum are separated from the means or methods of achieving these outcomes. If mathematical knowledge depends on the contexts in which it is acquired and used, it is appropriate to consider the means, methods and situations in which it is constructed or used.

In the next sections, I describe the differences which studies in the field of situated cognition (Carraher et al., 1990; Lave, 1988; Saxe, 1991) have observed between learning mathematics in "out-of-school" (informal) and "in-school" (formal) settings. I then describe the instructional implications of these.
3.3.1.1 Learning in out-of-school situations

Out-of-school mathematics is largely practical. Mathematics is learned in relation to the contexts and goals in which problem situations emerge (Saxe, 1991). The goals of this mathematics are generated (not simulated) as the problem situation arises. They are goals accepted by the person engaging in the activity. The person is aware of and owns the goals to a large extent. Problem solving in out-of-school situations is carried out “in order to master a situation” and not “display knowledge” (Nunes, 1992). The problem solving activity arises from the need to make decisions for some purpose (for example, how much money to charge a customer), rather than performing computations for a deferred goal. It is carried out in ways that allow individuals to monitor the meaningfulness of the solutions to their immediate concerns and problems (for example, how much change one gets after a transaction).

Transactions in out-of-school situations involve some informal measurement or calculation. A lot of mathematics, forms of logic or empirical relations is embedded in such tasks or calculations. Carraher, Carraher and Schliemann (1985, p. 23) give an example concerning a seller who was asked how much a customer would pay for ten coconuts if each costs 35c. The seller used a procedure which appeared simple but its analysis revealed a lot of mathematical operations embedded in it. It is most likely that the seller was unaware of such operations, indicating that out-of-school mathematical operations are unconscious, not deliberate, but context-dependent.

Individuals use their knowledge to map one organisation onto the other. This is done largely “to meet their own needs and satisfy externally imposed tasks” (Lave, 1985, p. 206). It is the problem (the goal — why they are doing the calculation) that determines how and what calculation to do. Out-of-school mathematics does not have explicit rules or conventions. Individuals in out-of-school situations are at liberty to use informal strategies with which they feel familiar and competent (Bishop & de Abreu, 1991).

3.3.1.2 Learning in in-school situations

As a contrast, learning mathematics in in-school situations usually proceeds according to pre-determined aims and objectives of a curriculum. In-school mathematics has a set of rules and conventions which must be learned if the individual is to communicate effectively in mathematical terms. Lave (1985) argues that in-school mathematics teaches an ideology (p. 175), that is, a body of ideas that reflects the beliefs of a particular system. However, in most cases, this
takes place largely to the disadvantage of a majority of learners. Learning in in-school situations privileges only a few of the learners whose culture may be represented in school mathematics.

The curriculum for in-school mathematics is often inappropriate for the population it is meant to serve. This is exemplified in Lave's (1985) case study with Vai pupils in Liberian schools. She reported that the incorporation of American contexts in textbooks used in Vai classes may have caused conflict for students in terms of the frames of reference of the concepts they were learning. When this happens, there is usually an imposition of culture (Bishop, 1990b; Fasheh, 1989), an unfamiliar perspective to the way of life, by the school system on learners. Hence learners' needs and curriculum goals come into conflict.

In-school mathematics usually involves context-free algorithmic procedures for solving arithmetical problems. Since the algorithms are assumed to be context-free, it is suggested that they should be universally applicable (Lave, 1985, p. 174). However, research on everyday practices (Bishop & de Abreu, 1991; Brown et al., 1989; Carraher et al., 1985) is in conflict with this functional theory of school effects on cognition. Many curricula assume that students can learn mathematics, retrieve it from memory and apply it to a new situation. This assumption is inappropriate since it assumes that the transfer of learning to new situations occurs independently of the context, activity and process within which learning takes place. Furthermore, this assertion needs to be challenged since marked inconsistencies in performance between school and everyday situations have been observed (Boaler, 1993; Masingila, 1993). In-school mathematical procedures are not unproblematically “applied” to everyday contexts. Either they (school algorithms) are not used at all, or a mixture of in-school and out-of-school procedures emerges. Boaler (1993) emphasises that it is the context in which mathematics takes place, and not the problem to which it is applied, which determines the general performance and selection of mathematical procedures.

The research evidence in the area of situated cognition suggests that individuals participating in problem solving in out-of-school settings tend to be more successful than individuals doing problem-solving in in-school settings. The same individuals who are competent in out-of-school problem solving become handicapped when it comes to solving problems in school. There is a problem of transfer of knowledge between situations. This is manifested in differences in learning and problem-solving strategies between in-school and out-of-school practices. In this regard, Nunes, Schliemann and Carraher (1993) ask how it is possible that “children capable of solving a computational problem in the natural
situation will fail to solve the same problem when it is taken out of its context” (p. 23). In order to address this gap, it has been suggested, for example, that many of the differences can be narrowed by creating experiences that engage students in doing mathematics in school in ways similar to mathematics learning and practice outside of school. (Masingila, Davidenko & Prus-Wisniowska, 1996, p. 198)

Masingila, Davidenko and Prus-Wisniowska (1996) have argued that in order to incorporate everyday mathematics into the curriculum, it is necessary to study mathematics as it is actually used in specific contexts. For example, they studied the mathematics utilised by a restaurant manager and interior designer before designing related activities to be used by students. They concluded that

for both the restaurant manager and interior designer, solving the problems were necessary parts of their jobs. They used mathematics as a tool to help them solve problems and not as the goal of the problem. (p. 182)

They found that students viewed the problems as mathematical exercises and “immediately started using algorithms that they thought would be appropriate”. Trying to put themselves in the everyday problem situation did not help them to view the problems in terms of their everyday constraints. The students did not even check the meaningfulness of their solution to the everyday context.

Lave and Wenger (1991) have used the notion of “situation specificity” to describe the fact that the processes and procedures of activities are regulated by the situations in which the participants are being apprenticed. Drawing on Lave and Wenger’s (1991) notion of “situation specificity”, Boaler (1997, 1998) compared the mathematical work of students in a longitudinal case study of two schools in the UK with students of similar social class and abilities. Boaler (1997) compared the achievements of the students across a range of tests, including numeracy and standardised national tests across different age ranges of students. In one school, students learned mathematics through a textbook-centred approach. In the other, the students learned mathematics through open-ended projects with real-world applications. Boaler (1998) found that in short written tests set in different contexts “there were no significant differences in the attainment of the cohort of students at the two schools at the end of years 9 and 10 (agc 13–15)” (p. 115). However, in an “applied” task administered to the year 9 and 10 students at both schools, the students who learned through the textbook approach demonstrated that “they could use mathematics in tests, but many could not use the same areas of mathematics in applied situations” (p. 115). However, students who learned through open-ended projects were “equally capable in both” (p. 115). Also, in the national examinations (GCSE),
the students who learned through project work attained significantly higher
grades that those who used the textbook system.

In an interview, students who used the textbook system said that they could not
see any connection between the mathematics they learned in school and the
demands of their lives. More interestingly, three quarters of the year 10 and 11
students who solved real world problems in projects said that “they used their
school learned methods in situations outside school [but] did not perceive any
real differences between the mathematics of school and the ‘real world’” (Boaler,
1998, pp. 115–116). These findings show that, depending on the context,
individuals may be able to transfer their knowledge between two contexts, in this
case, performance in tests. However, it demonstrates that although individuals
may transfer their knowledge as evidenced by their performance on tests, their
“beliefs, goals and interpretations of mathematical effectiveness” may not only
be contrary to the “cognitive interpretation of performance” but may also be

The notion of transfer itself needs to be challenged. The analysis of transfer needs
to be broadened to include issues related to students’ beliefs and confidence in
their use of mathematics in “real world” situations. For example, one of the
students in Boaler’s study said that “she could use the mathematics, ‘not the
actual same things as the activities, but things [she] could use them in’” (p. 117).
This seems to confirm Billett’s (1998) theorising of the transfer problem when he
proposes the notion of “far” transfer and “near” transfer. He suggests that “the
degree of difference between the knowledge constructing activities in particular
settings is likely to [determine] whether transfer is ‘near’ transfer which is easy
because the target situation is similar or analogous to its source, or ‘far’ transfer
to circumstances which are novel” (Billett, 1998, pp. 2–3).

3.3.1.3 Implications of situated cognition for classroom practice

Various studies in situated cognition reveal that there are differences between
learning in in-school and out-of-school practices. Schliemann (1998) and
Verschaffel, de Corte and Borghart (1997) have reported that, when structurally
similar mathematical problems are given, the same children approach them
differently and perform differently when these problems are given in different
contexts. These studies have found that children already have the basic
conceptual understanding of mathematical knowledge from their everyday
experiences. Children only lack the conventional procedures and conventions to
relate their everyday knowledge to school mathematical terms. There have been
calls for the teacher to facilitate the incorporation of children’s informal
mathematics into the school curriculum. These studies have highlighted the need
for problem solving to accommodate the use of informal strategies and to take into account both cultural variations and personal differences in informal mathematics knowledge. This connection has the potential to offer students an enriched view of the world and understanding of mathematics. Additionally, these studies have brought together individual and social theories of learning and have offered “languages in which to describe the process whereby the environment constructs the individuals, as well as the reverse” (Lerman, 1998b, p. 345). These have also resulted in models such as “community of practice” (Lave, 1991) which help to analyse students’ participation in mathematics learning and apprenticeship to mathematics as a school discipline (Watson, 1998). However, there are two fundamental questions that needs to be addressed.

The first one concerns the problem of transfer. To what extent can connecting mathematics learning and everyday experience adequately lead to students understanding school mathematics? Although Boaler’s (1998) study suggests that there is some potential to achieve this, the problem of transfer still needs to be addressed from different perspectives. There is also the question of the relationship between out-of-school and in-school situations. According to Lerman (1998a), there are both epistemological and pedagogical similarities and differences between the two situations. Both of these settings are similar to the extent that they are regarded as “social practices”. However, a significant difference which has not been adequately addressed concerns Lave’s notion of “becoming”. Lerman (1998a) states that

the school student’s needs in relation to acquiring knowledge, when those needs are not antagonistic to the school’s intentions, are somewhere on a spectrum from spending the day peacefully and easily to gaining the right qualifications to pass onto the next stage of becoming an independent adult in the world. (p. 35)

Similarly, Adler (1998) has elaborated that in school students remain students until they leave. No matter how much mastery they might have achieved, only a few, after school, might become mathematics teachers and even fewer mathematicians. (p. 169)

The goals of the students may not be about becoming a mathematician or a mathematics teacher. Indeed, the teacher may not necessarily be a mathematician as it is often taken for granted. Hence applying the concept of becoming, and using the concept of “community of practice” to understand the social relationships in schools needs to be further addressed and analysed since in-school and out-of-school practices are inherently different in terms of the goals and intentions of their participants.
The second question concerns the subject matter of mathematics itself — the content of mathematics. The question is: "where is the mathematics?" in these so-called situated cognition studies? This is posed in view of the general status of the focus of these studies. This question is clarified from an ethnomathematics perspective. Ascher and D'Ambrosio (1994) have pointed out that some mathematicians have narrowly used ethnomathematics since their use is much too specific to the elementary school level and, as a result, minimise the mathematical ideas that are really out there in the non-school settings ... If you say, for example, that mathematical ideas have to do with counting and then you go out and look for culturally embedded mathematical ideas, what you will find is counting. That is too small; it is too small. Certainly mathematical ideas of number, logic, and spatial configuration organised into systems, include counting. But counting doesn't include all those wonderful things that are in mathematics and that are mathematical ideas ... So many people who are inspired by the concept of ethnomathematics are involved in the elementary school mathematics level and they are, perhaps, looking for too restricted a set of ideas. (p. 37)

Arguing from an academic mathematics standpoint, some researchers have queried whether incorporating everyday modes of thinking and knowledge in the curriculum might lead to a "ghetto curriculum", thereby discouraging students from looking beyond their everyday experiences (Abraham & Bibby, 1992; Floden et al., 1987). This is argued on the basis of wanting to preserve the present status of the discipline of mathematics which offers rigorous training in logical thought.

Floden Buchmann and Schwille (1987) have explicitly said that

By emphasising continuity, educators destroy some of the strengths the separateness of schools can provide ... . While giving learning power, [experiences] also restrict people's scope of vision, exaggerate the reliability and importance of close-to home experience, and make it difficult to properly understand concepts from the academic disciplines. (p. 486)

Floden et al. (1987) have further argued that

We aim to recover the meaning of school as a place set apart, where truth and the social order do not coincide. This implies stressing disciplinary understanding as a central goal of schooling". (p. 502)

The above remarks seem to support a view of education which puts boundaries between socialisation and formal education. According to Egan (1987, p. 508), Floden et al. (1987) "defend the proper role of the school as a place set apart from existing social conventions and assumptions, owing allegiance rather to the traditional pursuit of truth". While ensuring that the discipline of mathematics is preserved and treated as a masterpiece as it has traditionally been, it might be more appropriate to consider the view that using everyday experiences in teaching mathematics offers a "considerable potential for learning and
understanding mathematical concepts in people who have often been treated as unfit to learn mathematics in school" (Nunes et al., 1993, p. 153).

Other researchers have argued for a broadening of the conceptualisation of the teaching of mathematics to include older students who are learning higher level mathematics. In this regard, Ascher and D'Ambrosio (1994) have argued that at all levels of schooling the teaching of subject matter is intertwined with the teaching of culture. [Adults] are already fully enculturated (emphasis added). As a result, ethnomathematics may have even more important ramifications for their education. If part of the pedagogical purpose of ethnomathematics is a revitalisation of mathematics education, that aspect would be particularly important for this older group. And, since they have had many life experiences, some of which may have involved utilising mathematical ideas, they could make significant contributions to our [and their] understanding. (p. 43)

The point here is not to consider street mathematics as "lesser mathematics" as Nunes et al. (1993, p. 153) have also commented. Everyday mathematics needs to be seen, in whatever form, as a legitimate human construction necessary for the functioning of different practices and cultures but also for furthering our understanding of school mathematics. Less visible from the analysis of situated cognition studies is the "formalisation" of street mathematics to become formal school knowledge representations. This lack of explicit formal connection between street mathematics and school mathematics seems to be consistent with Nunes' (1993) remarks that "the mathematics used outside school is a tool in the service of some broader goal, and not an aim in itself as it is in school" (p. 30, emphasis added).

3.3.2 The Realistic Mathematics Education approach

A more specific way of formalising the connections between school mathematics and the real world is suggested by the proponents of the Realistic Mathematics Education approach (Freudenthal, 1981; Streefland, 1991; Treffers, 1991). This approach was developed as a Dutch response to the worldwide need to reform mathematics education consistent with changes in the goals of mathematics education, theories of learning, society, and mathematics (de Lange, 1993b).

Nunes et al. (1993, p. 154) have commented that "Realistic Mathematics Education appears to be successful in bringing children to build their knowledge of school mathematics on the foundation of their already available knowledge of street mathematics". Situated cognition researchers study the nature of knowledge acquired in in-school and out-of-school settings. They attempt to uncover problems and inconsistencies in people's knowledge in these settings, and suggest that there is a need to make connections between these settings
during formal teaching. The Realistic Mathematics Education approach takes reality, including out-of-school situations, as starting points for learning mathematics. It formalises students' knowledge of representations of mathematics in everyday situations into formal mathematical knowledge. This approach has a mathematical focus. It is a broad and conceptually rich approach, and encompasses a developmental research program into children's mathematical understanding and conceptual development.

Researchers in Realistic Mathematics Education (de Lange, 1993b; Freudenthal, 1991; Streefland, 1991) have proposed that using everyday phenomenon (reality) provides viable opportunities for students to actively engage in constructing their own understanding of mathematics. In the realistic approach, students themselves become constructors or producers of their own mathematics starting from open problem situations (Streefland, 1991, p. 19). This approach, which constitutes a highly compatible, domain specific instructional theory (de Lange, 1996, p. 59), has strong connections with constructivism (Van den Brink, 1991; Heuvel-Panhuizen, 1994). The approach relies on real world applications and modelling and has the following tenets: conceptual mathematisation, free productions, interactive learning, integrated learning strands, and authentic assessment.

In the following sections, I describe each of these components of the Realistic Mathematics Education approach and draw some implications for this study.

3.3.2.1 Conceptual mathematisation

Conceptual mathematisation is defined as "the process of developing mathematical concepts and ideas starting from the real world" (de Lange, 1996, p. 57). In this process, the learner is given tasks that proceed from reality, that is, from the learner's "ever expanding living world" (Freudenthal, 1991, p. 136). In the realistic approach, the development of concepts starts with the real-life applications of the concepts, rather than with the formal system (the final product) (de Lange, 1993b, p. 5). The learner explores and interacts with the concrete situation. In this way, the learner develops, extracts or reinvents appropriate mathematical concepts. Learners "invent" concepts which are new to them but may be well-known to the teacher (Freudenthal, 1991, p. 48). This reinvention process begins with students' informal mathematical activities while aiming at supporting the emergence and development of "increasingly sophisticated ways of symbolising and understanding" (Gravemeijer, McClain & Stephan, 1998, p. 194). The students produce "models", which serve as models of the situation and models for mathematical reasoning (p. 196). The existence of this "local instruction theory" with the model of and model for heuristic is argued to be
highly instrumental in the learning process. The use of this heuristic is not visible in classroom practices in other contexts — see, for example, Groves' (1998, pp. 214–216) analysis of learning through problem solving in Japanese mathematics classes.

There are potential advantages of this approach. Firstly, when knowledge is acquired by the learner's own activity, it is more understandable and more readily available than when imposed by others. Secondly, discovery can be enjoyable. Therefore, learning by reinvention is motivating and enhances the attitude of experiencing mathematics as a human activity (Freudenthal, 1991, p. 47).

In the realistic approach, reality serves two interrelated purposes. Firstly, reality is a means by which a particular concept can be developed. Secondly, it serves as a way of applying the concept (de Lange, 1993b). Since the starting points for instruction are experientially real, students immediately engage in personally meaningful mathematical activity. This means that the relationship between the concepts and their applications in real life is shown right from the start rather than deferred and only revealed at the end of the learning process.

Apart from being experientially real for students, the starting points need to be authentic and mathematically engaging:

- the starting points should be justifiable in terms of their potential end points in the learning sequence. This implies that students' initially informal mathematical activity should constitute a basis from which they can abstract and construct increasingly sophisticated mathematical conceptions (de Lange, 1996, p. 60, emphasis added).

The situations or analogies must involve rich imagery and have the potential to support students' abstract activity and increasing mathematical abstraction.

### 3.3.2.2 Free productions

In the realistic approach, students are encouraged to produce their own descriptions of mathematics and their own ways of working in mathematics.

During instruction, students are involved in activities in which they create and elaborate symbolic models of their informal mathematical activity. These activities involve students in making drawings, diagrams, notations or tables. This enables them to make reflections on the path they have taken in the learning process. It also means that students will be led to anticipate a continuation of this process. Freudenthal (1991) and Van den Brink (1987) state that students' free productions may be of an informal nature, reflecting students' fragmentary knowledge (Freudenthal, 1991, p. 20). These free productions are a result of reflection on constructions. In addition, students' free productions become an
essential component of instruction. The knowledge is negotiated in the learning process. In this case, students are asked to write about situations, do experiments, collect data, and draw conclusions. In this way, students are considered as curriculum developers. The materials that students produce are considered as a resource for other students' learning (Van den Brink, 1987).

3.3.2.3 Interactive learning

The role of discussion and collaboration is emphasised in the realistic approach. Groupwork, student-student and student-teacher interactions are essential components of the learning process. Groupwork serves two purposes. First, it is a source of explanation, and secondly, it is a source of confrontation with others. It is argued that confrontation adds significantly to the dynamics of the learning activity. For example, de Lange (1993b) suggests that contradictions coming from [a] partner, due to the fact that they are explained, are more likely to be perceived than contradictions confronting the solitary learner, derived only from facts. They are also harder to refute than in a conflict resulting from the individual and temporary hesitations between two opposing points of view that the solitary learner experiences when confronted with a problem (p. 5).

Students are involved in an interactive process of explaining, understanding, questioning, justifying, and reflecting on their own solutions.

3.3.2.4 Authentic assessment

In the realistic approach, assessment is considered to be an integral component of the teaching-learning process rather than regarded as an after-lesson activity as it is assumed in traditional classrooms. The notion of authentic assessment is grounded in the following way. Being an approach inspired by changes in theories of learning (constructivism in particular), assessment in the realistic approach reflects constructivist learning. The methods for assessment procedures reflect the goals of the curriculum as well as those of the students. Students' (own) free productions are an important component of the assessment process. In addition, assessment is context dependent. Context-independent generalised testing is argued to be unjust (de Lange, 1993b, p. 6). In this case, the context of assessment not only reflects the students' real world, but also the "real world of mathematics itself" (de Lange, 1993b, p. 13). This means that assessment problems needs to involve students' abilities to think and communicate mathematically, that is, to demonstrate higher order thinking skills associated with the discipline of mathematics.

Realistic Mathematics Education researchers such as Heuvel-Panhuizen and Gravemeijer (1991) note that mathematics tests are often associated with written
tests consisting of bare sums of increasing difficulty. They argue that such tests do not give sufficient information about the progress of instruction children’s abilities and strategies. Heuvel-Panhuizen and Gravemeijer (1991) therefore suggest that the most open way to uncover what students are capable of doing is to elicit their own productions (p. 152). This is done by asking students to think up problems rather than to solve “bare sums”. Such an approach not only reveals what students are capable of doing but also their problem-solving processes. Presenting students with situations in which they are allowed to work in their own ways has the possibility of enabling them to show creativity in their solutions, portray a problem-solving attitude, and reveal their full learning potential. In other words, students take control over the assessment process.

3.3.2.5 Practical implications of Realistic Mathematics Education

Realistic Mathematics Education is a stronger perspective than situated cognition as far as building formal mathematical knowledge is concerned. The Realistic Mathematics Education approach has significant focus on the extraction, development and formalisation of the mathematical aspects of a real world situation. The main aim of engaging students in experientially real contexts is to enable them to construct mathematics and to demonstrate students’ capacities to engage in “increasingly sophisticated mathematical abstraction”. A significant aspect of students’ learning consists of mathematisation, which, according to de Lange (1996) involves both the “horizontal” and the “vertical”. The activities to promote horizontal and vertical mathematisation, involves students, to a large extent, in mathematical modelling processes. Horizontal mathematisation is aimed at “transferring the problem to a mathematically related problem” (de Lange, 1996) and involves the following activities:

- identifying the specific mathematics in a general context,
- schematising, formulating and visualising a problem in different ways, discovering relations, discovering regularities, recognising isomorphic aspects in different problems, transferring a real world problem to a mathematical problem, transferring a real world problem to a known mathematical model. (p. 69)

When the problem has been “transferred to a more or less” mathematical problem, this problem is treated with mathematical tools to transform the real world problem into mathematics. The process of mathematisation involves students reflecting on their actions (de Lange, 1996, p. 69). Hence mathematisation is considered to be essential for all students. Gravemeijer, McClain and Stephan (1998, p. 194) have pointed out that as students formalise their reasoning, the mathematical model “gradually take[s] on a ‘life of its own’ independent of situation-specific imagery” (p. 196, emphasis added). Ultimately,
the aim is for students to think as much as possible in mathematical terms rather than in concrete terms.

Following from above, there are two main limitations of the realistic approach. The first, similar to that of the situated cognition perspective, concerns the problem of transfer. There is a need to address this problem, and to ask, as de Lange (1996) has stated, the question: "If we introduce concepts by means of real world problems, how can we make sure students know to use those concepts in other situations?" (p. 93). The difficulty here is also whether all students would be able to engage effectively in mathematical modelling processes. This also questions the characterisation given to the Realistic Mathematics Education as "common-sense mathematics" (Gravemeijer, 1993, p. 54).

The second concerns the need to address "questions about relevance, think more critically about the role of mathematics in our society" (de Lange, 1996, p. 93). The challenge concerns students' ability to use, recognise, reflect on mathematics in a critical society. This concerns the critical issue of providing a mathematics education which is sensitive to the cultural and political realities of schooling. While the Realistic Mathematics Education approach starts with reality (everyday experiences), the socio-political realities which impact on students' lives have not been given explicit consideration in this approach. As de Lange (1996) has acknowledged,

A "real world" curriculum is culture dependent: what might work in one cultural setting may not work in another one — even if the underlying mathematical concepts are the same. This relates quite heavily to the argument of democratic competency: the critical attitude may be desirable in all civilizations, but [an] effective critical attitude will depend on the state of democracy (among other things) in that culture. (de Lange, 1996, p. 92, emphasis added)

School mathematics is not just an individual or social discourse. It is shaped by social and political individuals and institutions. It is a result of arguments between educators, politicians, mathematicians and school officials. These impinge directly on students' learning and therefore cannot be ignored. Although the Realistic Mathematics Education approach is a "developmental research" program, the "development" has so far been limited to the discipline of mathematics, problem solving and modelling. Explicit links between mathematics education and society need to be addressed with stronger and more socio-cultural and political sensitivities than have been advanced in Realistic Mathematics Education or from situated cognition perspectives.
3.3.3 Critical mathematics education

This section considers critical mathematics education, a third perspective for connecting everyday experiences and school mathematics learning. It will be argued that by taking into account the political nature of mathematics education, critical mathematics education represents a significant departure from situated cognition and Realistic Mathematics Education. The key constructs of critical mathematics education: critical competence, critical distance and critical engagement will be described in this section, together with the implementation of these which involves a process of reflective knowing. Classroom consequences of practising critical mathematics education are described and discussed together with their implications for this research.

3.3.3.1 Background information and key constructs used in critical mathematics education

Critical mathematics education as an approach for connecting everyday experiences and school mathematics has promising implications for mathematics education, especially in developing countries such as Malawi. Rooted in critical theory and Freirian pedagogies, critical mathematics education has been associated with the work of Skovsmose (1994) and Frankenstein (1987), and from an ethnomathematics perspective, the work of D'Ambrosio (1990) and Gerdes (1985). Critical mathematics education and ethnomathematics have been discussed in various terms by different mathematics educators. However, Ernest (1991) and Abraham and Bibby (1992) have used the term “public educator ideology” to indicate that critical mathematics education and ethnomathematics have an engagement with critical awareness, social change and research that makes explicit connections between mathematics, mathematics education, and society.

The public educator ideology has a liberatory framework since it regards everyday experiences, informal modes of thought and interests as part of mathematics education, while simultaneously liberating learners from the tyranny of the conventions of academic mathematics. In so doing,

The public educator perspective ... takes a somewhat more interactive approach in that the kind of mathematics which is seen as appropriate for the curriculum is built on a view of society which takes account of different constituencies of interests, including the cultural interests of the learner. (Abraham & Bibby, 1992, p. 182)

The public educator framework can be described as a border line discourse (Skovsmose, 1985). This is because it addresses the discipline of mathematics (education) and other areas related to it. Consequently, it has the potential to attend to all the possibilities and constraints in this educational process. It uses
everyday experiences as a context for posing problems about mathematical knowledge and transforming the educational processes of all learners.

Taken as separate perspectives within the public educator ideology, critical mathematics education and ethnomathematics approaches have been used in various ways in their relationship with mathematics and classroom practice. The framework of critical mathematics education is a reaction to the “disciplining and suppressive features of mathematics education (in its traditional forms with traditional content) coming from ‘inside’ the highly technological societies” (Skovsmose & Nielsen, 1996, p. 1272). Ethnomathematics reacts to the same features of mathematics education, but, according to Skovsmose and Nielsen (1996), it does so from “outside” the technological societies.

The ethnomathematics framework has generally been associated with a reaction to “modernisation theory” (Vithal & Skovsmose, 1997, p. 132), colonisation and cultural imperialism. However, according to D’Ambrosio (1981, 1990), who coined the term, ethnomathematics is a holistic approach since it considers the classroom as an essential component of the learning process but also considers cultural aspects beyond the classroom.

The concept of environment goes beyond the classroom and includes the entire life history of a child .... When children go to school they carry with them their personal history, full of experiences accumulated in living in a particular family, in a particular community, and these different environments result in experiences which include customs, perceptions, explanations, mysteries. Some have experienced, in their previous life, approval, acceptance and have learned to master situations; others have experienced humiliation, rejection, and have even faced failure. (D’Ambrosio, 1990, p. 14)

This broad perspective is reflected in the framework of ethnomathematics as:

the mathematics which is practised among identifiable cultural groups, such as national-tribal societies, labour groups, children of a certain age bracket, professional classes, and so on. (D’Ambrosio, 1985, p. 45)

More recently, the above characterisation of ethnomathematics has been broadened to denote “the arts or techniques developed by different cultures to explain, to understand, to cope with their environment” (D’Ambrosio, 1992, p. 1184). Taking culture as a departure point, and considering that any culture (western or non-western) has a culture of its own, Bishop (1988b) has elaborated that mathematics can be analysed and developed through a system of everyday activities. According to Bishop (1988b)

There are, from my analyses, six fundamental activities which I argue are both universal, in that they appear to be carried out by every cultural group ever studied, and also necessary and sufficient for the development of mathematical knowledge (p. 182).
These activities are: counting, locating, measuring, designing, playing, and explaining. Bishop (1988b) further elaborates that "mathematics, as cultural knowledge, derives from humans engaging in these six universal activities in a sustained, and conscious manner" (p. 183, emphasis added). In addition, these activities "would allow the mathematical ideas from different cultural groups to be introduced sensibly" (p. 189). Some mathematics educators have also added that a "decontextualisation" and "recontextualisation" of these activities would make them more didactically accessible to the classroom setting (Chevallard, 1990, p. 12). It is the fundamentality and universality of the activities which makes ethnomathematics a holistic program for change and development in mathematics education.

Although critical mathematics education and ethnomathematics have been described and used in different ways (see, for example, Barton, 1999; Bopape and Volmink, 1998; Gerdes, 1996; Powell & Frankenstein, 1997), the common purpose of these is to build an equitable, just and democratically-educated society. They are both a reaction to the exclusion of many individuals (due to inequitable educational resource provision and the hierarchies of mathematics) from actively participating in society and actively engaging in mathematics education which has so far been acknowledged and consistently argued to be a human activity for all.

Ethnomathematics and critical mathematics education seem to be united in their pursuit of a "critical education" which can be argued to support the following conditions:

If educational practice and research are to be critical, they must address conflicts and crises in society. Critical education must disclose inequalities and suppression of whatever kind. A critical education must not simply contribute to the prolonging of existing social relationships. It cannot be the means for continuing inequalities in society. To be critical, education must react to the critical nature of society. (Skovsmose, 1994, p. 22, emphasis in original)

An education that takes into account the above conditions has critical consequences for classroom practice. Vithal and Skovsmose (1997) have clarified this point in their critique of ethnomathematics and how it might be conceptualised and practised in South African schools. They have argued that "in South Africa bringing students' backgrounds into the classroom could come to mean reproducing those inequalities into the classroom" (p. 146). Instead of focusing on students' backgrounds which may be coloured by past inequalities, Vithal and Skovsmose have therefore argued for education to focus more on students' "foregrounds".

In some of the very diverse (culturally, socially, politically and economically) classrooms in South Africa, and given its history, a
focus on foreground, a common shared future, may be preferred by learners while a focus on background, on difference, may be resisted. Rather than only looking back, it has been argued that a curriculum needs to equally reflect the diversity of a changing South Africa where new possibilities are made visible and available. (p. 150, emphasis added)

This emphasises the view that any education that considers the fact that some individuals (or forms of knowledge) have been excluded from the dominant discourse is bound to be political. An education that recognises the need to include students’ backgrounds and foregrounds and their histories is likely to involve students reflecting on their (polarised) political histories, which, according to Vithal and Skovsmose (1997), may not be unproblematically compatible with people’s current educational concerns.

From a critical theory perspective, educational theorists and practitioners have also argued for education for all. For example, critical theorists in the field, have suggested that

> Schools need to be defended as an important public service that educates students to become critical citizens who can think, challenge, take risks, and believe that their actions will make a difference in the larger society. This means that public schools should become places that provide the opportunity for literate occasions, that is, that provide opportunities for students to share their experiences, to work in social relations that emphasise care and concern for others, and to be introduced to forms of knowledge that provide them with the conviction and opportunity to fight for a quality of life in which all human beings benefit. (Giroux, 1989, p. 214, emphasis added)

With respect to education, Skovsmose (1994) argues that conflicts or inequalities in society create differences in opportunities in school. These differences need to be understood both in terms of educational principles and in terms of critical education. Also, since schooling produces knowledge, ideologies, routines and competencies, the achievement of a critical education can only be possible if it takes into consideration the cultural background of schooling and develops possibilities for students’ awareness of these differences and conflicts and competencies of dealing with these. This means that students need to be informed of these conflict situations (that is, they must have access to information and knowledge) but also be provided with opportunities in which they can develop their understanding of and subsequent action on their situations.

Skovsmose (1985) developed the terms critical competence, critical distance and critical engagement as a response to the critical nature of mathematics as characterised by its formatting power which is illustrated in the following description by Davis and Hersh (1986).
We are born into a world with so many instances of prescriptive mathematics in place that we are hardly aware of them, and, once they are pointed out, we can hardly imagine the world working without them. Our measurements of space and mass, our clocks and calendars, our plans for buildings and machines, our monetary system, are prescriptive mathematicalisations of great antiquity. To focus on more recent instances ... think of the income tax. This is an enormous mathematical structure superposed on an enormous pre-existing mathematical financial structure .... The effects of the income tax are felt by everyone .... In American society, there are recent or recently reinstated prescriptive mathematicalisations: exam grades, IQ's, life insurance, taking a number in a bake shop, lotteries, traffic lights ... telephone switching systems, credits cards, zip codes ... school rating systems .... We have prescribed these systems, often for reasons known only to a few; they regulate and alter our lives and characterise our civilisation. They create a description before the pattern itself exists. (pp. 120-121)

The point here is that mathematics makes a real intervention in everyday life. It colonises our realities and forces us to live with abstractions. Mathematics gives a lot of power to very few people and to objects and machines. In so doing, it humanises machines and dehumanises people. Skovsmose (1994) has described mathematics as “an activity which simultaneously solves and creates critical (conflicting) features in society” (p. 56, emphasis added). With this power of mathematics in mind, Niss (1983) has suggested that it is of democratic importance for individuals and society at large to have access to “instruments for understanding the role of mathematics”. A lack of these, according to Niss, makes an individual to become

a “victim” of social processes in which mathematics is a component.
So, the purpose of mathematics education should be to enable students to realise, understand, judge, utilise and also perform the applications of mathematics in society, in particular to situations which are of significance to their private, social and professional life. (p. 248)

In order to deal with and analyse the cultural exclusion, mystery, and formatting power of mathematics, Skovsmose (1985) proposed the use of three key constructs which are central to critical mathematics education discourses. These terms, which concern the conditions of the teaching-learning process, the mathematics curriculum and its functions in society, are: critical competence, critical distance and critical engagement.

**Critical competence**

According to Skovsmose (1985), the concept of critical competence requires students to have a capacity to be involved in and in control of the educational process. They must recognise that their experiences, though of a “faulty [or] fragmentary” nature, are “relevant both in relation to students’ immediate interests [and] to the general perspective of the educational process”
(Skovsmose, 1985, p. 340). Students' existing capabilities and experiences should be seen as equally important to the progress of the educational process. The teacher should not impose these experiences. Doing so could socialise students to believe that their own experiences, interests, concerns, needs and purposes are inferior.

**Critical distance**

The concept of *critical distance* requires both students and the teacher to be involved in “curriculum critique” (Skovsmose, 1985, p. 340). This concept interrogates the content of mathematics education. It addresses questions about the “knowledge-constitutive interests” connected with mathematics, its applicability, assumptions, functions and limitations. Questions involved in the critique of mathematics content include:

Who use[s] it? Where is it used? .... Which questions and which problems have generated the concepts and the results in mathematics? Which contexts have promoted and controlled the development? .... Which possible social functions could the subject have? .... in which areas and in relation to which questions is the subject without any importance? (Skovsmose, 1985, pp. 340–341)

The notion of critical distance involves stepping back and critically examining the relationships between the curriculum and the purposes it is intended to serve. The above questions interrogate the legitimacy and uses of mathematics in society. They aim to provide a deeper understanding of the social inequalities in society which traditional forms of mathematics, as presented in word problems in textbooks, for example, do not reveal.

**Critical engagement**

The third concept, *critical engagement*, concerns the “conditions outside the educational process” which can be used in identifying problem areas to be used in the teaching-learning process (Skovsmose, 1985, p. 341). The problems must be closely connected to “existing social problems” and be relevant, in a subjective sense, to students’ perspectives. That is, “it must be possible to encircle and define the problem in close connection to the experience and conceptual framework of the students” (p. 341). For the educational process to foster critical engagement among students, it must involve them in soliciting mathematics problems to be used in the classroom. The teacher and students must be “co-investigators” of problem areas (Freire, 1972; Shor, 1980), that is, the problems need to be identified by both the teacher and students.

Taken together, the key terms *critical competence, critical distance, and critical engagement* constitute what Skovsmose (1992) and Frankenstein (1998) call
"critical mathematical literacy" or "mathemacy". These entail that students have access to information and different forms of knowledge and are able to see themselves as capable of participating in and contributing to the development and further understanding of mathematics and its functions in their everyday realities. Consequently, students are empowered (rather than socialised) to believe that their existing knowledge and experiences are legitimate starting points for learning about mathematics.

3.3.3.2 The implementation of critical mathematics education in the classroom

The practice of critical mathematics education in the classroom has typically involved the use of projects structured around themes related to specific aspects of students' everyday lives.

In her work, Marilyn Frankenstein has focused on helping students to relearn mathematics in a non-suppressive way. The aim is to help them understand mathematics in a way that enables students to use mathematical knowledge to understand the "taken-for-granted assumptions about how our society is structured, and to act from more informed choices about those structures and processes" (Frankenstein, 1989, p. 2). Frankenstein uses real-life data (for example, from newspapers) as a basis for posing questions in order to deepen students' understanding of social and political realities and to change their perceptions of these. This is aimed at achieving an "emancipatory" mathematics education since this approach problematises reality (Gerdes, 1985). Gerdes has concluded that

A problematising reality approach as starting point is in itself already a confidence-creating activity. Problematising reality, reinforced by cultural, social and individual-collective confidence stimulating activities will contribute substantially to an emancipatory mathematics education, to enable everyone and every people to understand, develop and use mathematics as an important tool in the process of understanding reality, the reality of nature and of society, an important tool to transform reality in the service of an ever more human world. (p. 20, emphasis added)

Frankenstein's work involves mainly adult students aged 30 and above. These are working-class students who have typically been labelled "failures" in secondary school (Frankenstein, 1990, p. 106). They have been "tracked" from college and have "internalised negative self-images about their knowledge and ability in mathematics" (p. 106). The aim is to promote critical mathematical literacy among students, with specific objectives being to:

help [students] realise that [they] already know some maths; make [them] confident that [they] are capable of learning any mathematics; help [them to] learn about the learning process, so that [they] can
control [their] own learning through such actions as self-evaluation and formulation of specific questions to clear up misunderstandings; and counter the myth that "slow" means "stupid". (Frankenstein, 1989, p. 4)

These objectives are dealt with in specific themes such as "mathematics anger: mathematics is not useless and boring" (pp. 27–32). Frankenstein (1993) describes a curriculum she has developed which uses real data from the different situations in the United States to analyse the influence of social class upon housing, health care and other social institutions.

Practising critical mathematics education in the classroom has several consequences. According to Frankenstein (1990, p. 108),

students initially resist this approach because they feel learning mathematics is hard enough; connecting math with other subjects and having to read and write in a math class, just makes learning the mathematics much harder”.

This point has also been noted by Pollak (1968) concerning the difficulties of “bringing applications into mathematics teaching”. Pollak claims that students (as well as teachers of mathematics) “frequently do not know very much about any field of application, and yet we want to work with situations, as well as mathematics, that they can understand” (Pollak, 1968, p. 28). Students may therefore resist the need to work outside the field of mathematics. However, according to Frankenstein (1990), this resistance is eliminated when students notice that “learning mathematics in a non-fragmented way connects math with their interests and their lives” (p. 108). This resistance to engaging in empowering strategies has also been reported in the work of Breen (1990) with preservice mathematics teachers.

Drawing on the work of Frankenstein (1989) and Powell and Hoffman (1990), Kibi (1993) investigated the practice of critical mathematics education in a mathematics club at a school in Tanzania. The club, which was open to all students at the school, had the following aims:

to help students to revise school work; to promote the reading of mathematics books outside the prescribed textbooks; to introduce and promote mathematical games as a form of mathematical activity, to promote study groups; to forge a link between what is learnt at school and other day-to-day activities. (Kibi, 1993, p. 57)

Students investigated their immediate environment and collected information about their farms, the hospital, administration offices, the garage and workshops. Kibi (1993) found that students' involvement in these activities reduced apathy and “opened [students'] eyes to a number of questions, both political and economic” (p. 57). In one activity, a student followed an office worker and found that the worker wasted about 28 days a year through late
coming, extension of lunch time and going home early from work”. Students’ participation in revision of school work reduced their anxiety and gave them confidence in mathematics.

In the club activities, the teacher’s role was to “introduce conflict, even where the students thought they agreed” (Kibi, 1993, p. 64). Due to the emphasis placed on discussions, the club activities instilled active participation among students. This effect was reflected in the way students began to respond in the classroom. However, during classroom lessons, teachers, especially mathematics teachers, “felt threatened” and started pointing to the “unruliness of the students in class [and] how argumentative they had become” (p. 64, emphasis added).

It seems that the teachers saw “arguments” as undesirable elements in the classroom. It is also quite possible that having conducted these activities outside the classroom contributed to a possible separation, in teachers’ thinking, between learning “outside” the classroom and learning “inside” the classroom.

Skovsmose (1994) used the thematic approach in a broad framework that involves the process of “reflective knowing”. The process of “reflective knowing” recognises that mathematics has a very extensive range of applications which are often “hidden” and hence difficult for both primary and secondary school teaching to present illustrative examples of real-life applications (Skovsmose, 1990). Although they are hidden and often difficult to identify, these applications of mathematics have a “society-shaping” function because

It is impossible to imagine a development of society of the type we know without technology playing a major role and with[ou]t mathematics playing a dominant role in the formation of technology. (Skovsmose, 1990, p. 111)

The pedagogical consequence of the above is that since mathematics applications are often difficult to identify, mathematics education has a “hidden curriculum” which results in students receiving a variety of impressions during an educational process. Due to its hidden curriculum,

mathematical education socialises [students] into quite another direction than that optimistically presumed in “official” statements about the potential epistemological functions of mathematical education ... . Students learn that some people are able to manage technological problems, and that some are not. And, consequently, the “incapable” students learn to become servile towards technological questions and to become servile towards those who can manage. (Skovsmose, 1990, pp. 114–115).

Skovsmose (1994) has argued that in order to develop democratic competences among students (which involves having critical competence, observing a critical distance to mathematics, and being critically engaged in the educational process), mathematics education must be based on dialogue between students and the
teacher. This implies that there is a need to institutionalise democratic structures at the classroom level in order for mathematics education to have some impact at the macro-society level. The teaching-learning process must, therefore, involve active reflection not only about mathematics but also about students' relationships with mathematics and the broad society in which they are living.

Skovsmose (1994) has therefore proposed six dialogue-oriented entry points which could be used in mathematics teaching in order to promote reflective knowing among students. These entry points are:

1. Have we used the algorithm in the right way?
2. Have we used the right algorithm?
3. Can we rely on the result of the algorithm?
4. Can we do without formal calculations?
5. How does the actual use of an algorithm, appropriate or not, affect a specific context?
6. Could we have performed the evaluation in another way?

(Skovsmose, 1994, p. 120)

Questions 1 to 3 have a focus on the mathematical content and the process of using mathematical tools. In particular, question 2 interrogates the relevance of using mathematical tools for pursuing our aims. This takes into consideration the context of the use of mathematics, and whether using a particular mathematical tool gives a result which has some value, that is, which we can actually use for the purposes we have in mind. Question 4 interrogates the legitimacy of using formal calculations, and whether we can rely on intuitive interpretations of the situation in question.

Question 5 is central to the discourse of critical mathematics education. It directly addresses the uses and the formatting power of mathematics, that is, how the application of a particular mathematical tool affects our conception of the world. Question 6 is a meta-reflection question. It makes a reflection on the uses of mathematics and whether using entry points 1 to 5 represents a productive inquiry aimed at developing mathematical knowledge. The main aim of these questions is to challenge the established structures of mathematics and to reflect on the role of mathematics in society.

The aim of involving students in this reflective process is to enable them to gain consciousness about the educational process. This consciousness is achieved through:

- Firstly, engagement with some form of organised mathematical activity...
- Secondly, objectification of some mathematical problem, i.e., the distancing of oneself from the problem so that it is seen clearly as the object of study.
- Thirdly, critical reflection upon the purpose and consequence of studying this problem in relation to wider values.

(Abraham & Bibby, 1992, p. 187, emphasis added)

Using a thematic approach and accompanied by a process of reflective knowing, Skovsmose (1994) involved teachers and students in several projects. One of the
projects had a theme called the “Economic Relationships in the World of a Child” (Skovsmose, 1994). This project involved investigations in terms of sub-themes such as pocket money, child benefit allowance and money needed for a youth club (pp. 63–68). In this project, children demonstrated increased mathematical abilities and “real engagement” even from those who were normally seen as less able (Skovsmose, 1994, p. 69).

In the “Golfparken” project, students investigated ways of transforming a piece of land in such a way that they could see it as a fascinating area in the school neighbourhood. In this project, one of the teachers complained that “the mathematical content [of the project] was not developed very much. Students did not see much mathematics in the project even after the researcher had discussed the different situations to demonstrate the calculations that were involved (Skovsmose, 1994, p. 90). This happened in spite of the project having incorporated many opportunities for bringing mathematics in use. “The children had opportunities to use a variety of mathematical competencies but did not recognise that they had performed any mathematics” (p. 94).

Skovsmose’s (1994) “Family Support in a Micro-Society” project involved 20 students aged between 14 and 15. The project involved students in an activity of distributing a certain amount of money as a child benefit among 24 hypothetical families. The students were divided into groups and each group had to decide an algorithm for distributing the child benefits. Factors such as the number of children in the family, their income levels, and families which had disabled children were considered. The students found that they had to make several modifications and simplifications to the data and the algorithm they used to calculate the benefits in order to produce distributions which were feasible and meaningful. However they had to defend their distributions based on reality. For example, one group had decided that each family would receive the same child benefit not on the basis of wanting to simplify additional computations, but on having argued that

it is also expensive not to have children. A couple without children often want[s] to have children, and in many cases this means that [they] become involved in different clinical investigations”. (Skovsmose, 1994, p. 131)

The thematic approach has also been used from an ethnomathematical perspective by Pompeu (1992). His investigation was in line with the broad conception of ethnomathematics as a research program that seeks to understand the anthropological, historical and philosophical connections between mathematics and culture, and to incorporate this understanding in education, that is, “how education should be modified when this understanding has been
achieved” (Ascher & D’Ambrosio, 1994, p. 40). Using action research, Pompeu (1992) investigated this educational component of ethnomathematics by incorporating and analysing “cultural” and curriculum development approaches described by a number of leading specialists (see, for example, Howson, 1983; Bishop, 1988a; D’Ambrosio, 1985; Gerdes, 1985; Mellin-Olsen, 1987; Zaslavsky, 1973).

Pompeu (1992) investigated the influences of an ethnomathematical approach on teachers’ and students’ attitudes to mathematics education. He conducted his investigation in four phases which concerned:

- the identification of human activities which could be mathematically interpreted in the classroom at the intended, implemented and attained levels;

- the practical work with teachers which involved them in the development of the following six project activities based on Bishop (1988a): “The Skipping Rope” project — a counting project; “The Hop Skotch” project — a locating project; “The Windmill” project — a measuring project; “The Queimada Game” project — a playing project; “The Hot Air Baloon” project — a designing project; and “The Brazilian Economic Plan” project — an explaining project;

- the application of the six teaching projects which involved 19 teachers in eighteen different classes in twelve different schools. These activities involved a total of 450 pupils aged between 6 and 16. Each project runs for three to five weeks and used between 15 and 25 hours of mathematics class time; and

- the analysis of the effects of the teaching projects through the use of questionnaires, observations and interviews.

Pompeu (1992) found that all the teachers emphasised mathematics as a debatable rather than one-way subject, and almost 80% of the pupils liked the teaching projects because of the interest which the projects brought to the mathematics lessons. However, teachers complained that they experienced difficulties in planning, developing and implementing the teaching projects based on real-life situations. For example, one teacher complained about having “lost too much time in organising [pupils in] groups”. The teacher “had to ask several times for silence [and] felt that pupils were not used to being questioned, and to working in groups” (Pompeu, 1992, p. 278).

Pompeu also found that some teachers had difficulties understanding pupils’ knowledge. The teachers also needed more time and materials to prepare their
lessons. Some teachers “could not plan by themselves a sequence of activities through which mathematical concepts could be developed and explored. They were unable to act as micro-curriculum developers, or problem solvers, or even independent thinkers” (p. 280). Pompeu (1992) concluded that if mathematical knowledge is to be considered as “shared between pupils and the teacher, then teachers must show pupils how to assess and be critical of their own work” (p. 281, emphasis added). In addition, Pompeu concluded that “teachers must not be bounded by time if we want to implement the Ethnomathematical approach in a successful way” (p. 301).

3.3.3.3 Implications of critical mathematics education to classroom practice

The findings described above have a number of implications for the present study. These mainly concern the problem of transfer and consequences for classroom practices that take into account the political nature of mathematics education.

Transfer

Based on her experiences in working with adult students, Frankenstein’s critical approach has shown that it has the potential to help students to relearn mathematics, to reduce apathy and anxiety about mathematics. Although this approach may be resisted, Frankenstein claims that students overcome this resistance when they find that mathematics connects with their interests and everyday lives.

Kibi (1993) applied Frankenstein’s work in his research at a school in Tanzania. He concluded that students participated more actively and were more argumentative in their learning of mathematics. However, the fact that teachers felt threatened with the students’ new attitude to learning highlights a problem of transfer which was also described in Sections 3.2.3, 3.3.1 and 3.3.2. It seems that while teachers seem not to have raised any concerns about students being argumentative in club activities, their having found arguments undesirable in the classroom indicates that the teachers saw mathematics learning in club activities and in the classroom as different situations serving different purposes. This indicates that promoting dialogue and reflective knowing from “outside” the classroom (in club activities) may not have desirable consequences “inside” the classroom, in so far as teaching demands may be concerned. Connected to this, Skovsmose (1994), who also conducted a variety of project activities with teachers “outside” the assigned classroom timetable, concluded that
It does not make sense to substitute a traditional mathematics education with a critical one, leaving the structure of the timetable untouched. Some of the boundaries around the mathematical classroom must be broken down for some periods — but I do not argue that a permanent “breaking down” has to take place. In “our Community” [project] the eradication of the boundaries around the subject took place over a fairly long period, and perhaps this is what is essential. The traditional teaching of mathematics cannot be substituted with critical mathematics education without attacking the regular timetable structure. Critical mathematics education demands a degree of interdisciplinarity which presupposes structural flexibility. (p. 151)

Skovsmose calls for a reorganisation of the teaching structures in mathematics and recommends a flexibility to teach mathematics outside the allocated time. Given teachers’ resistance to active dialogue promoted from “outside” the classroom, as reported in Kibi’s (1993) study, it seems more appropriate to confront the traditional nature of the classroom from “inside” it in order to change it. The issue therefore is about investigating the possibilities and constraints for changing mathematics learning and teaching by working from “inside” the classroom rather than outside it. Pompeu’s (1992) investigation which showed that teachers placed emphasis on mathematics as a “debatable” subject after participating in teaching projects based on an ethnomathematical approach is therefore worth building on.

The second issue also concerns the problem of transfer. Skovsmose (1994) reported that in one project, some teachers complained that students were not able to see any mathematics in the activities even after discussions about the different calculations involved. This also happened irrespective of the fact that the project had many in-built illustrations of mathematics in use. Pompeu’s (1992) study revealed that teachers had difficulties understanding pupils’ knowledge and developing activities through which mathematical concepts could be developed. These findings highlight the difficulty of identifying mathematical knowledge in everyday life and the subsequent translation of these to school knowledge which can be seen as mathematics. The question therefore is: To what extent does involving teachers and students in project activities based on real-life practices enable them to see these practices as mathematical? What kind of mathematics does this generate?

**Implications of politicising mathematics education for classroom practice**

Another issue concerns the politically-oriented nature of critical mathematics education whose consequences need to be addressed further. Mellin-Olsen (1987) has argued that mathematics education is already a political activity especially
as it relates to assessment. He suggests that failure in school mathematics is a political act since some students are prevented from becoming part of the mathematical knowledge system because of the nature of curriculum designs or examination procedures. Formal examination procedures, for example, act as signposts indicating who proceeds or stays behind in mathematics. The curriculum determines what is seen as valued knowledge in school mathematics. Mellin-Olsen claims that mathematics becomes more meaningful when the mathematical projects and activities done by students form the basis for taking positions and action about issues in their communities.

Ernest (1991) points out the strengths of practising a critical mathematics education as follows:

[The public educator ideology] is the only ideology with the explicit aim of enhancing the self-realisation of the learner both as an autonomous human being and as a member of society. It is the only ideology fully committed to social justice, with regard to the social and political implications of providing “mathematics for all”, or better “mathematics by all” ... Secondly, this is the only perspective to accommodate a fallibilist or social constructivist philosophy of mathematics, representing the leading edge of contemporary thought. Consequently, the public educator mathematics curriculum reflects the nature of mathematics as a social institution, with all the powerful educational implications of this perspective. (Ernest, 1991, pp. 210–211)

More recently, Carlson and Apple (1998) have pointed out that the advantage of critical education approaches is that they have increased the number of voices that need to be made public. They have helped legitimate and/or generate a welcome return to the concrete analysis of particular ideological and discursive formations, as well as their multiple sites of elaboration and legitimation in public documents ... and institutions such as schools. (p. 34, emphasis added)

Carlson and Apple (1998) have argued that critical approaches have allowed individuals to search for hidden structural constraints and to understand the “complexities of the local and the contingent” (p. 34). They have allowed the possibility of openly focusing on the totality of the person rather than on individualistic boundaries.

However, one of the strongest criticisms against the use of critical education approaches concern their implementation in the real classroom. Ernest (1991) has commented that:

The introduction of contentious social and political issues, and the encouragement of student questioning of subject matter, pedagogy and assessment will lead to conflict and controversy in the classroom ... This may differ radically from the mode of teaching learners have previously experienced ... and may be unsettling and disturbing to learners. Controversy, conflict and rational argument are not only
missing from much of educational practice, but are also alien to many
of the cultural backgrounds of learners. (Ernest, 1991, p. 212, emphasis
added)

Abraham and Bibby (1992) have also argued that the idea of giving the "masses"
access to knowledge which the "upper classes" would not have can be
threatening to some people in politically powerful positions, leading to a
possibility of social instability.

Skovsmose's (1992, p. 8) characterisation of the entry points to reflective
knowing as "small steps" needs to be seriously addressed, especially in terms of
the practical classroom implications. The questions involved in this reflective
knowing process such as "Have we used the algorithm in the right way? Can we
do without formal calculations? and "How does the actual use of an algorithm ...
affect a specific context?" are not small questions. They demand not only that
teachers and students have or are able to develop pedagogic spaces which could
accommodate such discussions, but also that there is access to some relatively
higher reflective competencies than might be possible in a typical classroom.
Critiquing mathematical knowledge might be an overwhelming activity for both
the teacher and students who may be more used to transmissive pedagogies.

In order to address the problematic nature of practising a critical mathematics
education, Ernest (1991) suggests that the degree to which practising a critical
mathematics education may be a threat depends on the context and the specific
strategies by which it is practised. He further claims that it can be fully
implemented with students in later years than with younger children. With
respect to the younger children, and referring to the work of Cobb (1987) and
Yackel (1987), Ernest (1991, p. 213) notes that the critical approach may still be
an effective learning strategy if the conflict between the children is over answers to
mathematical problems.

The above remarks have strong implications to practising critical mathematics
education in African schools, and in developing countries, in general. In his
research in African schools, Harber (1990) explored the role that social studies
curricula played in creating citizens who are critically aware of their everyday
realities and gain capacities necessary for social action. Harber (1990) argues
that an education which emphasises doubt and uncertainty is incompatible with
"traditional, didactic forms of teaching where the teacher formally transmits
factual knowledge from the front of the class and where learners passively
receive it, memorise it and repeat it in examinations" (p. 27). Such practices
reflect a view of knowledge as
static, as made and finished, and of learners as empty and lacking
consciousness. Critical education, on the other hand, means involving
students in their own learning and interpretation of the world — [through] dialogue, questioning, participation and discussion (p. 28).

Hawes' (1979) remarks still apply in many African schools today:

Consider the case of a teacher brought up in the hard school where right answers are rewarded by praise and wrong answers by cane. Now he is being invited to learn along with the children ... to admit ignorance (he the headmaster!), to reward discovery learning when neither he nor the children know the answer. Seldom wonder that he seldom responds to the challenge. (p. 79)

The traditional cultural patterns of societies from which teachers come will seldom have encouraged the questioning of received wisdom or the practice of reflective inquiry. Teachers will also usually have experienced both in their own schooling and teacher training, a traditional view of what constitutes knowledge.

It seems clear from above that if change initiatives in mathematics education do not challenge the broad socio-political conditions of schooling, then they cannot challenge the classroom situation, the culture of silence, and the transmissive styles of teaching predominant in African classrooms.

What are the implications of practising a critical mathematics education approach and using dialogue as a tool in learning about mathematics in Malawi? To what extent does this approach enable students to pose critical questions about mathematics and challenge its role in their lives and society?

3.3.4 Summary

The perspective of situated cognition studies students' cognition in different contexts, characteristically represented by in-school and out-of-school situations. Situated cognition identifies differences between these contexts and suggests a knowledge corpus which is assumed to be real and useful for classroom practice. The classroom context is not the immediate field of action in these studies. Instead, students who appear to do well outside the classroom stimulate interrogation of classroom practices and their limitations on student learning.

On the other hand, Realistic Mathematics Education approach, through its notion of conceptual mathematisation, formalises everyday knowledge into formal mathematical knowledge. However, it pays little attention to the cultural and political realities of students' involvement in mathematics learning. Once the situation has been mathematised, students seem to be encouraged to think independently of the concrete situations which facilitated the mathematisation of situations. The mathematical model (that is, the mathematics) sustains a life of its own independent of the situation. Keitel (1993) has illustrated the impact of this abstraction as follows:
Mathematisation ... means formalisations, which offers an autonomous, self-contained, decontextualised and depersonalised description of structural relationships, independent of experiences, however useful the latter might have been in the formalised construction. It is obvious that a formalisation does not distinguish between human beings and other objects. Formalisation in the case of mathematics means the creation of a formalised language, and also formalised routines, forms of behaviour .... While the result of a formalisation of language is a new language, the results of a formalisation of routines are manuals — descriptions and prescriptions of how to behave in an algorithmic way .... Interpreting the mathematical instructions by military orders, working instructions or juridical laws, the concept of a mathematical algorithm turns into concepts of social institutions like the military, business companies or jurisdiction. (p. 24)

In both situated cognition and Realistic Mathematics Education, the political context of education is not adequately addressed. Fasheh (1990) has argued that there is need for a mathematics education that "responds to real needs, empowers people, builds networks, raises questions about assumptions and consequences" and one that "keeps oscillating between life and structures, and facilitates the transformation of mental and social structures" (p. 34).

The overriding framework of situated cognition and Realistic Mathematics Education is social constructivism, which has as its main preoccupation, the "construction" of mathematical knowledge. However, the philosophy of critical mathematics education, through Skovsmose's concept of "reflective knowing" goes beyond and considers, as its object of study, the "uses of mathematics". The focus is on stepping "outside the cathedral of formal knowledge to take a more general view of this construction" (Skovsmose, 1992, p. 8). In other words, reflective knowing is an open activity that may include much more than questions having to do with mathematics and mathematical modelling. It considers the broader cultural and political spaces in which students are located. The critical mathematics education approach is therefore a richer and broader perspective to adapt for investigating change in mathematics learning and teaching in Malawi.
CHAPTER 4

METHODOLOGY

The nature of the problem can dictate which approach is best likely to illuminate it. (Connole, Smith, & Wiseman, 1993)

There is widespread consensus among researchers that one chooses a research methodology according to the research questions being asked.

4.1 The research question

The literature reviewed in Chapter 3 has shown that using everyday experiences in the classroom has the potential to change various aspects of student learning such as interest and confidence in mathematics, participation in classroom discussions, engagement in critical thinking and reflection on the use of mathematics in everyday life. A major problem identified in the literature has been students' abilities to understand school mathematics when teaching connects mathematics and everyday experience. The literature has shown that students have difficulties recognising the presence of mathematical ideas in everyday-life situations. Students have difficulties transferring their knowledge and skills from real life to school mathematics.

The literature has also indicated that using everyday experiences in the classroom has enormous implications for the teaching of mathematics. Teachers have difficulties connecting everyday experiences and school mathematics. This is because of the extensive knowledge and professionalism required on the part of teachers to enable them to facilitate the process of connecting everyday experiences and school mathematics. Although making connections between everyday experiences and school mathematics has the potential to improve student learning, this depends heavily on the culture of the mathematics classroom and teachers' abilities to create pedagogic spaces for negotiation, reflection and critical use of mathematics.

The description of the Malawian educational context (see Chapter 2) has shown that while various educators and researchers have been examining the possibility of providing an education which connects secondary school mathematics and students' everyday needs and realities, these proposals and discussions have not been supported by any empirical studies with students and teachers in Malawian classrooms.

On the basis of the reviewed literature and the educational context of Malawi, this study addresses the following question:
To what extent can everyday experiences be used as a vehicle for changing the learning and teaching of secondary mathematics in Malawi?

This chapter discusses the methodological decisions made in order to answer this question.

### 4.2 Different methodological approaches

There is a need to distinguish between the terms method and methodology and their connections to research questions. To contextualise the distinction, Manstead and Semin (1988) have used an analogy and called researchers to imagine an individual who wants to cross a river. Various options are available: swimming, rowing or sailing a boat, floating a raft, building a bridge, hang-gliding, flying and so on. The task of crossing the river is analogous to the research questions being addressed, and the various means of crossing the river are analogous to the research methods available. The means of crossing chosen by the individual will depend on factors such as the number of people who wish to cross the river, the frequency with which they want to make crossings, the prevailing weather and current conditions, and so on. Similarly the type of research chosen by the investigator will depend on the ultimate goal of the research. (pp. 60–61)

According to Robson (1993, p. 38),

> The task of crossing the river corresponds to the general research focus. Specific research questions are analogous to asking how many people want to cross the river; the frequency ... and the current ... The choice of research strategy [methodology] is akin to a choice between swimming, walking, flying or sailing... The research tactics [methods] concern the particular type of boat, bridge, aircraft.

Methodology is an umbrella term for all the decisions made in an attempt to seek answers to research questions. It is an ontological and epistemological theory that guides the way we think about the world generally, and, in particular, the way we pursue a specific investigation (Lincoln & Guba, 1985; Preston, 1997).

A wide range of methodological approaches have been described as falling into four main categories. Connole et al. (1993, p. 12) calls these the empiricist, interpretive, critical, and postcritical (poststructural, postmodern, or deconstructive) approaches. These approaches, though considered to be on a continuum, have distinct features which depend on their epistemological and ontological bases. These features include assumptions about reality and knowledge; the foundations of the data and how it is collected; the products of the inquiry; and the interests and values inherent in the inquiry (Connole, 1996).

A similar distinction, which is based on the purposes of an inquiry, is presented by Lather (1992). Lather distinguishes the approaches according to their intentions: that is, to predict, understand, emancipate, or deconstruct (p. 89). I
will review these approaches here rather than attempt to distinguish between "qualitative" and "quantitative" approaches, because the latter are considered to be at the level of method rather than methodology (Lather, 1992, p. 90). The purpose is to use this review to reflect on and justify the approach I chose to use to conduct the investigation.

4.2.1 The empiricist approach

According to Connole, Smith and Wiseman (1993), the defining feature of an empiricist approach is that it assumes a "realist" rather than a "relativist" position to the nature of reality. The empiricist approach claims the existence of reality as independent of our knowledge of it. As such, the empiricist approach distances the researcher from the objects of the research. Hence, in the process of knowing, the researcher is expected to preserve objectivity through "clear and unambiguous rules of observation which are not modified by the setting and are totally independent of it" (Connole, 1996, p. 20). The main interest of the empiricist approach is to provide quantitative evidence with the purpose of generalisation and prediction, irrespective of the values that may be embedded in the process.

4.2.2 The interpretive approach

The interpretive approach, which is associated with the terms "qualitative" and "naturalistic", is based on the assumption that humans act intentionally. In order for human behaviour to be effectively understood, it is regarded as intentional. People's beliefs about what they are doing are an integral part of the research enterprise. As such, the interpretive approach regards aspects of its study as multiple realities, beliefs, and meanings (Wiseman, 1993). The interpretive approach identifies, describes and analyses subjective meanings. Questions about why individuals use these meanings are posed. The accounts of these meanings are reflected on with the research participants, through social interaction such as dialogue.

4.2.3 The critical approach

The critical approach shares the assumptions of the interpretive approach. In addition, it considers knowledge as problematic and provides a "critique of the ways people think" and examines the "social and cultural conditions that actually produce the words we use, and the way we see things" (Kemmis, 1996, p. 3). A distinguishing feature of the critical approach is its emancipatory character: it intends to "empower those involved to change as well as to understand the world" (Lather, 1992, pp. 87-88, emphasis in original).
Furthermore, the critical approach aspires to improve human existence through a process of "undisempowerment":

when we find that we have a group of people who are disempowered, who are prevented from speaking, who aren't recognised. ... then, by working with them, ... , we will be working to find ways that they can reduce their disempowerment. (Kemmis, 1996, p. 13)

The critical approach is a tool for social change. By working in a situationally specific and concrete world, this approach attempts to shape people to deal with practical questions and decisions in their lives (Kemmis, 1996, p. 10).

4.2.4 Postcritical approaches

Postcritical approaches are loosely defined but share the emancipatory character of the critical approach. Their central purpose is to challenge our understanding of knowledge as truth. This is achieved through interrogation of various discourses which constitute the field of inquiry, through the use of language. Postcritical approaches interrogate texts in order to uncover social relations and institutional biases underpinning knowledge and truth (Beavis, 1996).

Figure 4.1 on the next page, which has been adapted from Connole (1996), summarises the basic features of these approaches.

4.3 Choosing an approach

In choosing a methodology to be employed in the study, it is imperative that epistemological and ontological considerations be taken into account. Inherent in these considerations are the questions embedded in the conceptualisation of the study, and the relevance of the approach taken to answer the questions (Connole et al., 1993, p. 297).

4.3.1 Reflections on the intended study

This study intended to investigate change in student learning and teaching. It's aim was to investigate the extent to which everyday experiences could be used as a vehicle for changing the learning and teaching of secondary mathematics in Malawi.

This investigation was guided by two assumptions about implementing and studying change in the teaching of mathematics. The first concerns the constraints inherent in the process of change. Asking teachers to make connections between everyday experiences and school mathematics learning would place heavy demands on their teaching, especially if it was an approach they had never previously seriously considered in their normal practices.
<table>
<thead>
<tr>
<th>Empiricist</th>
<th>Interpretive</th>
<th>Critical</th>
<th>Postcritical</th>
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<tbody>
<tr>
<td>Reality is unitary and can only be understood by scientific method</td>
<td>There are multiple realities which require multiple methods for understanding them</td>
<td>Multiple realities are problematic</td>
<td>There is no reality or real world accessible to us beyond language. Reality is constituted in and through language</td>
</tr>
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**Foundations of data**

| Disciplined observation | Meaning is the basis of data and precedes logic and fact | Meanings are found in language and social behaviour | Language as a system of meaning. There is no fixed meaning; meaning shifts according to its context |

**Ways of observation**

| Through clear and unambiguous rules which are not modified by the setting and are totally independent of it | Through the skills (social/linguistic/cognitive) of the researcher | Interpretive methods and self-critical reflection | Interrogation of various discourses and analysis of power relationships |

**Products of the inquiry**

| Generalisable laws based on objective evidence | Knowledge which is dependent on process, context, and the researcher's skills | Knowledge within the interpretive framework | Theories about how knowledge is constructed and constituted |

**Inherent interests of the inquiry**

| Prediction and control | Discovery of meanings and beliefs underlying actions of others | Interpretive interests and improvement of human existence | Questions of interpretations, marginalisation, domination and power |

**Inherent values of the inquiry**

| Knowledge inherently value-neutral | Knowledge interpreted in terms of values being represented | Knowledge never value-neutral and represents certain group interests | Truths and knowledge are contested, never value-neutral and are effects of power |

*Figure 4.1: Approaches to inquiry (adapted from Conole, 1996, pp. 20–21)*
Ball (1993) pointed out the following in terms of the constraints this might have on teaching:

*How do I create experiences for my students that connect with what they now know and care about but also transcend the present? How do I value their interests and also connect them to ideas and traditions growing out of centuries of mathematical exploration and invention?* (p. 375, emphasis in original)

The above comments, when considered together with the lack of qualifications in many teachers in African schools and the cultural and institutional constraints reviewed in Section 3.3.3.3, mean that connecting everyday experiences and school mathematics learning is an enormous task for teachers.

The above comments, when considered together with the lack of qualifications in many teachers in African schools and the cultural and institutional constraints reviewed in Section 3.3.3.3, mean that connecting everyday experiences and school mathematics learning is an enormous task for teachers. It is therefore necessary to work with teachers and to recognise the classroom constraints under which they work. Stephens, Lovitt, Clarke and Romberg (1989) advise that:

Any program which seeks to enhance the quality of teaching and learning in mathematics must convey to teachers, in practical terms, a clear image of what these changes might mean in the classroom. (p. 223)

One of the most important starting points for changing mathematics teaching is current practice (see, for example, Breen, 1997; Owen, Johnson, Clarke, Lovitt & Morony, 1988; Stephens, Lovitt, Clarke & Romberg, 1989; Wilson, 1992). Current practice involves *what* teachers do in their classrooms and *why* they do it. It recognises the institutional constraints which shape teaching and learning.

According to Wilson (1992), investment in teacher development is the most crucial step that needs to be taken in order to improve the conditions of mathematics teaching in African schools. The teacher is seen as the most important resource for school mathematics. Educational development and improvement depends on the professional development of practitioners — that is, teachers. There is a need to democratise research so that the energy of many teachers who are normally denied opportunities to investigate problems of real concern is released (Breen, 1990; 1993). Lortie (1975) argues that “teachers have an in-built resistance to change because they believe that their work environment has never permitted them to show what they can really do” (p. 235).

In discussing teacher development activities, Cooney and Krainer (1996) have pointed out the importance of listening to teachers' concerns. They argue that

*Listening [is] the foundation from which teacher education should be conducted. Listening honours teachers and provides a context in*
which inservice education can be based on what teachers know rather than on what they don’t know. Listening ... promotes reflection which can lead to a conception of teaching grounded in adaptation, a condition necessary for professional development. So conceived, listening creates an atmosphere of understanding and mutual respect between researcher and teacher. (p. 1181)

Many other authors such as Lortie (1975) and Thompson (1984) have argued that teachers have very practical orientations to professional development activities. They look for specific ideas directly related to their classroom actions. For this reason, effective professional development needs to understand teachers’ motivation, and to recognise teachers’ critical task of balancing competing demands from purposes, curriculum and teaching resources and approaches in their classroom conditions (Yaxley, 1991). Teacher development activities undertaken in isolation from teachers’ ongoing classroom responsibilities, which do not directly address teachers’ perceptions of the constraints on their situations, have been argued to be ineffective (Bishop, 1998). For this reason, Popkewitz (1984) advised that the change agent needs to be located within and not outside the organisation, since the aim is to interest those within the school to promote change.

The second assumption concerns the dynamics of the change process itself. Guskey (1984) pointed out that many teacher development activities do not succeed because they do not adequately consider factors related to the process by which change in teachers takes place. A common model of teacher development has a linear nature and assumes that changes in teachers’ beliefs and attitudes will lead to specific changes in their classroom practices and behaviours which, in turn, will result in improved student learning (Guskey, 1984, p. 6). Guskey (1986) argues that this model is inappropriate since it views change as something that is done to teachers. It regards teachers as “either lacking appropriate teaching skills (which the in-service program will provide) or as actually engaging in inappropriate practices (which the in-service program will identify and correct)” (Clarke & Hollingsworth, 1994, p. 154).

Guskey (1986) proposed an alternative model of teacher change which consists of the processes shown in Figure 4.2 below.
According to this model, significant change in teachers' beliefs and attitudes is likely to take place only after changes in student learning outcomes have been observed. In addition, students are conceived as "constantly making decisions about approach, progress and completion of learning" in response to their prior experiences and interpretations of various learning tasks (Baird & Mitchell, 1986, p. 12). Such student behaviours influence teachers' thinking and actions in the classroom. In seven case studies reported by Sullivan and Leder (1992), students' responses to teaching were found to be foremost in teachers' thinking. Consistent with the findings reported in Doyle (1986) and Desforges and Cockburn (1987), Sullivan and Leder (1992) found that teachers planned and interpreted classroom activities in terms of students' reactions and behaviours.

Clarke and Peter (1993) developed an alternative model of the teacher change process which was modified by the Teacher Professional Growth Consortium (1994). This model, shown in Figure 4.3 on the next page, views teacher change as "teacher professional growth", that is, as an on-going learning process.

According to the Interconnected model, teacher change occurs in four areas or domains of teachers' world: the Personal Domain (teacher knowledge and beliefs), the Domain of Practice (classroom experimentation), the Domain of Consequence (salient outcomes), and the External Domain (sources of information, stimulus or support). The change process is non-linear and occurs through mediating processes of "enaction" and "reflection". Enaction is the process by which change in knowledge or beliefs is translated into changed practice while reflection is seen as the key mediating process by which changes in teachers' knowledge and beliefs are brought about. The role of professional development activities is to stimulate and support informed teacher experimentation. The interconnected model allows for the emergence of a "complete description of the individual teacher" and an "emergent picture [that] sets out what the teacher knows, what the teacher believes and what the teacher does" (Clarke & Peter, 1993, p 174).
External Domain

Personal Domain

Teacher Knowledge and Beliefs

Domain of Practice

Classroom Experimentation

Domain of Consequence

External Source of Information, Stimulus or Support

Salient Outcomes

(thick arrow = enactive mediating process; thin arrow = reflective mediating process)

Figure 4.3: The Interconnected model of teacher professional growth (Teacher Professional Growth Consortium, 1994)

It is the multiple and interconnected ways through which teacher professional growth occurs which is of paramount importance here. Sparks and Loucks-Horsley (1990) and Bopape and Volmink (1998) argue that teachers learn many things on their own through reading professional publications, sharing their experiences and engaging in discussions with their colleagues, apart from attending formal in-service activities. Furthermore, Adler (1998) indicates that knowing about teaching and becoming a teacher are evolutionary processes, and deeply interwoven in ongoing activity in the practice of teaching. Knowledge about teaching is not acquired in courses about teaching, but in ongoing participation in the teaching community in which such courses might be part. (p. 164)

Ridgway, Swan, Howarth and Coupland (1984) and Burkhardt (1989) have illustrated that change is a gradual and difficult process. In addition, Burkhardt (1989, p. 10) has argued that change processes which involve only “exceptional” teachers are not likely to be accepted by “typical” teachers.

Based on his experiences from the Project for Enhancing Effective Learning (PEEL), Northfield (1992) pointed out that teachers need to persevere and be prepared to take “personal risks” in order to engage in new practices. This risk is often that of failure or embarrassment. Guskey (1986) argued that to change means to chance the possibility that students might learn less well than they do under current practices. Therefore, even when presented with evidence from the most carefully designed experimental studies, teachers do not easily alter or discard the
practices they have developed and refined in the demanding environment of their own classrooms (p. 9).

Therefore, in order to be successful, professional development activities need to be implemented sensitively and incrementally, within a supportive and constructively-critical framework (Fullan, 1993; Sparks & Loucks-Horsley, 1990). The change process also needs appropriate time considerations and a feedback mechanism which is not preoccupied with detecting failures or deviations to the real plan, but one that recognises teacher professional growth as an open-ended activity which involves real people and real situations where the overall purpose is to learn to change and to learn about change from teachers and students in their classrooms (Burkhardt, 1989). During the change process, the underlying dynamics are in many respects unknown, hence cannot be predetermined without considering the contexts of teachers who implement the change, and the learners who are supposed to be the key beneficiaries (Sullivan, 1998).

Following from the above assumptions and discussion, my interaction with the students and teachers could not be neutral: it would be coloured by my interest in seeing their pedagogical conditions change. My working with teachers would provide a stimulus that could lead to change and thinking about possibilities for change. I intended to describe and examine the meanings participants gave to such an interaction and the way it might orient their views about mathematics. In doing so, my study would share many characteristics of the interpretive approach but could also be supported by the critical approach, particularly in the analysis and further understanding of the context and extent of change. The empiricist approach could minimally support the study, mostly at the level of data collection. Over reliance on the empiricist approach would not be appropriate as this approach tends to disregard social, cultural and political values inherent in educational processes. However, I did not envisage the postcritical approaches to be of immediate and practical relevance to the study. The characteristics of interpretive and critical approaches are within the ordinary practices of everyday life and so would be immediately usable. Furthermore, my problematising of the ordinary nature of everyday life, through critical reflection, would be a useful learning experience for me.

Teachers or students could change for reasons directly or indirectly related to the interaction or stimulus I would bring to their context. Rather than base the study on an examination of some hypothesis, I was interested in studying understandings generated by my interaction with teachers and students. I had an initial question that led to the investigation. However, this remained tentative, bearing in mind that, although human actions are intentional (Wiseman, 1993), they cannot be tamed, controlled and predicted. An awareness of the
unpredictability of human behaviour requires the investigation to be broadened to accommodate pertinent issues impacting on the processes of schooling. As Burgess (1985, p. 4) writes,

the research is conducted within a theoretical framework. While there may be a small number of questions to orient a study, further questions may arise during the course of the investigation.

In taking this position, I was aware that, even within the limits of my investigation, issues could emerge that would call for a different analytical perspective. My choice of methodology therefore was not based on an absolutist conviction about the strengths of a particular methodology, but rather on a recognition that the inquiry and the decisions taken would represent a learning process that would be open to various ways of knowing. In assuming this stance, I concur with the following analysis:

Rather than attempting to understand the growth of knowledge as a revolutionary overthrow of one paradigm by another ... or as the accommodation of two or more paradigms ... the emphasis is on the ... growth in understanding that results from being open to multiple perspectives. Thus the point is not to accommodate or reconcile multiple paradigms of modern scientific thought; it is to recognise them as unique, historically situated forms of insight; to understand them and their implications; to learn to speak to them and through them; and to recognise them for what they are — ways of seeing that simultaneously reveal and conceal. The task of educational inquiry is ... to move beyond them, through dialogical discourse, to reconcile education with ideals of democracy and social justice. (Skrléc, 1990, p. 135, emphasis added)

There is a need to acknowledge the approaches as legitimate for their specific purposes, and to regard them as “competing” rather than “incompatible” approaches (Patton, 1988).

To provide an understanding of my position with respect to the criterion of relevance in choosing a methodology, I describe below the perspectives taken by Vulliamy and others concerning the appropriateness of qualitative methodologies in developing countries.

4.3.2 Educational research in developing countries

Qualitative research is claimed to be more appropriate in developing countries, such as Malawi, where its use in understanding major educational issues is relatively underutilised.

In advocating the use of qualitative research methods in developing countries, Vulliamy (1990b) writes:

There has been a tendency for the literature on education in developing countries to be concerned more with a discussion of policies and system-wide features than with observation of the realities of schooling at the chalk face. One of the main contributions
of a qualitative research strategy ... is in focusing on the actual implementation of policies in schools and thus assessing the points at which policy and practice converge and diverge. (p. 17)

Typically, educational research in developing countries has been concerned with routine monitoring of educational programs such as the documentation of national student enrolments, drop-out rates, examination performance, staffing, costs and resources. Consequently, in much of the developing world, educational research is largely empirical and quantitative, characterised by the development of standardised tests and questionnaires, the production of data from large samples of schools and individuals, and the analysis of these data by a variety of statistical methods. (Sheffer, 1986, cited in Vulliamy, 1990b, p.16)

However, such quantification reduces the visibility of the actual processes of schooling and makes it difficult to understand disparities between policy and practice. Vulliamy (1990b) argues that, where rigorous evaluations have been conducted, they have “nearly always utilised the traditional quantitative input-output research design” (p. 17). These evaluations have made extensive use of questionnaires and brief fact-finding visits to schools which tend to “reproduce the rhetoric of policies” (p. 17). These evaluations have often resulted in generalisations at levels far removed from the practitioner (Preston, 1997).

Fuller and Henneman (1989) present similar arguments when they call for research in developing countries to provide more textured portraits of life in classrooms ... concrete descriptions of how teachers interact with pupils, how student exercises are structured and evaluated, and what forms of knowledge are communicated. (p.17)

Fuller and Henneman (1989) indicate that little knowledge exists about how teachers in developing countries motivate students, and wonder whether they “simply try to maintain order when confronted by 50 or 60 young faces” (p. 17).

Various reasons have been given to explain the dominance of quantitative or positivist methodologies in developing countries. The reasons are mainly historical, cultural and political, and include imbalances in research training, the structure of funding and the size of formal systems of education (Preston, 1997). Crossley and Vulliamy (1997) write

[Although] qualitative research in education has a special potential in developing countries ..., for various historical and cultural reasons, educational research in such countries has, to date, been dominated by positivist strategies. Consequently, there have been many educational research questions in developing countries to which a quantitative strategy has been applied when either a qualitative one or a combination of the two would have been more appropriate. In addition, some research questions have rarely been addressed at all despite their potential relevance to both the process of policy-making
and to the more theoretical study of schooling in the developing world. (pp. 13–14)

The conduct of such research depends on "who asks whom to do what, how and why" (Preston, 1997, p. 32, emphasis in original). At issue is the question of who decides what research is to be done, with what resources and for what purposes. More specifically, educational research in developing countries is conducted by visiting (expatriate) researchers through aid organisations (Crossley & Bennett, 1997). In addition to being stereotypically quantitative, such research is "commissioned in [aid organisations'] interest as a pre-requisite for investment in large-scale development" (Preston, 1997, p. 45). This produces easily accessible but insensitive information. Such research assumes non-reflective roles largely determined by the researcher. It is commonly assumed that research methods and outcomes are not altered by the interests, local contexts and characteristics of individuals being studied (Preston, 1997; Valero & Vithal, 1998).

Other factors considered inhospitable to the wider use of qualitative educational research in developing countries have also been identified. In some countries the potentially critical nature of qualitative educational research has been considered as a threat to established policies (Vulliamy, 1990b, p. 21). Qualitative research may penetrate sensitive information which may not be disclosable. In addition, "the political threat that arises when oppressed groups find ways to give themselves voice" (Preston, 1997, p. 47) may be unwelcome.

Various researchers have questioned the accessibility of information obtained from quantitative evaluation research. Vulliamy (1990b) argues that such research reports are often difficult to interpret because "they assume, first, that the adopted policy is actually implemented and secondly, that this process of implementation corresponds to the policy directive (p. 17).

In addition, Vulliamy (1990b, p. 20) notes that in developing countries few teachers, administrators and policy makers are likely to have the benefits of advanced higher education or research training necessary to interpret the products of traditional statistically-oriented studies.

Because of the unsuitability and ineffectiveness of quantitative evaluation research methods, many critics of research done in developing countries have argued for the use of narrative research styles. The argument is that the narrative style inherent in qualitative research is more likely to reflect a social construction of reality that is recognisable and understandable to a wide range of experienced practitioners who do not have prior research experience. In particular, Vulliamy (1990b) has suggested that the narrative style of qualitative research may be well suited to cultural conditions in societies without the written systems of
communication which prevail more generally in developing countries. He emphasises that key qualitative research skills, such as interviewing and listening, build on prior capabilities that are already strongly developed in predominantly oral societies (Vulliamy, 1990b, p. 21). The advantages of personal field work, observations and face-to-face interviews are therefore more significant. Consequently, Crossley and Bennett (1997) and Broadfoot (1997) have reported a marked increase in the use of a variety of methods under the armory of case studies which are “complemented by the exciting potential of [methods] such as action research and ethnography” (Broadfoot, 1997, p. xii).

4.3.3 A case for using case study methods

In choosing a methodology for this study, general methodological approaches and research methods prevailing in developing countries have been reviewed. This review has indicated a need for a research approach that is open to multiple perspectives. In addition, it was imperative to adopt a research approach that had the potential to provide a deeper understanding of schooling processes. The interpretive/critical approach, as explained in Section 4.3.1, supports both of these conditions, and was therefore adopted for this study.

This study aimed at answering the question:

To what extent can everyday experiences be used as a vehicle for changing the learning and teaching of secondary mathematics in Malawi?

As explained in Section 4.3.1, learning or teaching practices could change for reasons directly or indirectly related to the research intervention. At the practical level, it was therefore imperative to use a research method which was responsive to participants’ situations and concerns and had the potential to focus the study as well as remain open to various perspectives on the learning of mathematics.

Tesch (1990) has provided a comprehensive review of specific qualitative research methods. Tesch recommends the use of case study methods when the researcher’s interest is in interpretation — “the comprehension of the meaning of text or action” (Tesch, 1990, p. 73). Authors such as Vulliamy (1990b) and Broadfoot (1997) have illustrated the potential of using case study and action research methods in developing countries. For reasons explained in the next section, the use of case study methods was considered more appropriate than action research as the former afforded more flexibility for the intended study.
4.3.4 Why not use action research?

Cohen and Manion (1980) have defined action research as:

a small-scale intervention in the functioning of the real world and a close examination of the effects of such an intervention... Action research is situational — it is concerned with diagnosing a problem in a specific context and attempting to solve it in that context; it is usually (but not inevitably) collaborative — teams of researchers and practitioners work together on a project; it is participatory — team members themselves take part directly or indirectly in implementing the research; and it is self-reflective — modifications are continuously evaluated within the ongoing situation, the ultimate objective being to improve practice in some way or other. (p. 174, emphasis in original)

Carr and Kemmis (1986) have described action research as consisting of a spiral of activities characterised by:

the identification of strategies of planned action which are implemented, and then systematically submitted to observation, reflection and change. Participants in the action being considered are integrally involved in all these activities. (pp. 164–165, emphasis in original)

In addition, Kemmis and McTaggart (1988) state that the activity of a group of teachers involved in action research consists of the group’s identification of a thematic concern. This concern defines the area in which the group focuses its improvement strategies (p. 9). Members plan strategies together, act and observe individually or collectively, and reflect together. All action research activities aim at improvement (Carr & Kemmis, 1986, p. 165). They aim to improve a practice and the understanding of the practice by its practitioners. In addition, the practitioners of the practice to be improved are involved in all phases of planning, acting, observing and reflecting.

The assumptions of action research as presented above would suit the implementation of the present study in the following way. The study had planned to involve the researcher and the teachers in planning mathematics lessons, implementing these plans in their classrooms, observing and reflecting on the effects of activities on students’ learning of mathematics and teachers’ teaching practices. It was envisaged that teaching mathematics using everyday experiences could improve learning and teaching in various ways. However, the use of action research methodology was not fully amenable to this study for two reasons. Typically action research involves practitioners in all phases of its activity. This study involved participants only in some of its phases. The study was initiated by my concern that mathematics teaching and learning in Malawian schools did not relate to the everyday contexts of students (see Chapters 1 and 2). However, I could not claim that the teachers I would work with shared my
concerns. From my perspective, the use of everyday experiences in teaching mathematics was an immediate concern since this reflected the kind of learning I most valued based on my previous learning and research training. This study did not adequately satisfy joint ownership of the research problem, as required by action research propositions.

The use of action research was also not appropriate because of the study time frame. Practitioners of action research have constantly argued that change in learning and teaching practices needs adequate time.

We now recognise that, in order to improve the quality of classroom teaching and learning, teachers must be provided with adequate and appropriate time, opportunities, guidance, and support to grapple with what is a difficult, demanding, and often unsettling process of personal change. (Baird, 1992, p. 148)

Considering the short time frame of the study, it was more appropriate to frame the investigation as a small-scale exploratory intervention — a case study to investigate possibilities for change in student learning and teachers’ teaching practices.

The defining features of case study methods and their relationship to the interpretive/critical approach adopted in this study are described in the next section.

### 4.4 Case study methods

Among the various types of qualitative research methods within the interpretive approach, case study has been characterised as an over-arching category (Mousley & Kortman, 1996). This characterisation of case study has a historical foundation. According to Tesch (1990),

> early researchers who conducted case studies “interpreted” their observations in the very basic sense of reflecting on their data until they achieved a better understanding of what they meant. (p. 69)

The use of case study methods in educational research emerged as a reaction to inadequacies of measurement studies “on” and “about” education (Walker, 1998, p. 41). Case study methods had the potential to provide insights “in” and “for” education, that is, the type of knowledge and understanding required for educational reform and curriculum improvement. Such information would provide a directly useful resource for more informed educational change.

#### 4.4.1 Defining case study

Various definitions of case study have been provided in the literature. Two of the most common state that case study is:
an examination of an instance in action. The study of particular incidents and events, and the selective collection of information on intentions and values, allows the case study worker to capture and portray those elements of a situation that give it meaning. (Walker, 1980, p. 4)

an inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and the context are not clearly evident. (Yin, 1994, p. 13)

These descriptions of case study are particularly relevant to the current investigation since they suggest that the inquiry is exploratory and focused around a phenomenon in action. Case study methods in education are most appropriate for studying interventions. They are suitable for answering how and why questions (Lancy, 1993; Yin, 1994). The investigator collects multiple sources of evidence to describe meanings of events or actions in the particular intervention. Case study methods are flexible and anticipate unintended consequences of action. The investigator, realising that there are “many more variables of interest than data points”, deliberately attends to contextual conditions believing that they might be pertinent to the questions under study (Yin, 1994). The reliance on a broad range of evidence such as interviews, observations, and document analysis makes case study methods achieve the purpose of triangulation of findings beyond what might be possible in a conventional quantitative study.

The most defining characteristic of case study methods lies in delimiting the object of study, the “case” (Merriam, 1998, p. 27). In education, typical cases of study are: a child, a classroom of a children, a teacher, an innovative program, or all schools in a country (Stake, 1995). Cases are studied in their own right, not as samples from populations.

The case itself is important for what it reveals about the phenomenon and for what it might represent. This specificity of focus makes it an especially good design for practical problems — for questions, ... arising from everyday practice. (Merriam, 1998, p. 29)

As Stake (1995, p. 3) argues, a case is chosen because researchers have a “research question, ... a need for general understanding, and feel that [they] may get insight into the question by studying a particular case.

Proponents of case study methods have constantly recommended that “cases” need to be bounded systems, that is, systems with some kind of outlines or boundaries (Stake 1988). The boundedness of the case emphasises that the aim of the researcher is to “try to figure out what complex things go on within that system” (Stake, 1988, p. 256).
This study recognises that the boundaries of the case are not fixed. As explained earlier, case study methods are flexible and accommodate unintended issues that turn out to be related to the aims of the investigation. Additionally, the people who set the boundaries and authentic themes are not only the researchers but all those who care about the [case]. That includes teachers at the scene, and it includes the readers of the case study. Certain things belong to the case, according to their expectations — so that boundaries and themes are set partly by those people anywhere who are interested in the case. (Stake, 1988, p. 258)

The teachers and students participating in this study were selected because of their potential to contribute knowledge about the question under study, as well as provide more understanding of change in mathematics education in Malawi. The teachers and students were selected from two schools which represented two of the three main types of providers of secondary education in Malawi. By involving teachers and students from two different types of schools, the study hoped to gain a broad view of issues related to the possibilities and constraints for changing secondary mathematics teaching and learning in Malawi.

4.4.2 Case study and interpretation

Typical of most qualitative research, case study research is interpretive (Stake, 1995). Stake (1988) argues that case study is “not just [about] writing a natural history, and not just telling .... It is about working on a conceptual structure, building up an understanding, [and] drawing some conclusions” (p. 255).

Case study researchers study and give insight into specific situations or events. They attempt to “understand how the actors, the people being studied, see things” (Stake, 1995, p. 12). In doing so, the investigation “gets beyond form and structure to the realities of human life” and reveals “what institutions [and knowledge] mean to individuals” (Walker, 1980, p. 4, emphasis in original).

Several researchers have grappled with the question: whose interpretations should prevail, the researcher’s or the people being studied? (Carr & Kemmis, 1986; Erickson, 1986; Walker, 1980). Arguing from an interpretive perspective, Carr and Kemmis (1986) have stated that interpretive social theory may influence practice by influencing the ways in which individual practitioners comprehend themselves and their situation. For an interpretive account, in trying to grasp the sense of individuals' lives and actions, may make use of concepts and understandings other than those used by the individuals themselves. (p. 91)

This perspective is supported by the “democratic mode” of case study research as outlined by Walker (1980) as he revisits the notion of the nature of research and the role of the researcher. Walker (1980) explains:
The democratic mode ... places the case study worker in the position of having to negotiate his interpretations with those involved in the study rather than being free to impose them on the data. The shift involved is a shift in power, a move away from researchers' concerns, descriptions and problems towards practitioners' concerns, descriptions and problems. (p. 8, emphasis in original)

The democratic mode of case study research, however, is conservative because "it presupposes values in the existing situation that need protection". Consequently, "it offers support, perhaps even unthinking support to the status quo" (Walker, 1980, p. 9). On the other hand, the researcher's perspective may dominate the inquiry:

Ultimately, the interpretations of the researcher are likely to be emphasised more than the interpretations of those people studied, but the qualitative case researcher tries to preserve the multiple realities, the different and even contradictory views of what is happening. (Stake, 1995, p. 12)

Having adopted an interpretive/critical approach to this study, I agree with Walker's analysis of the conservative nature of the democratic mode of case study research. The use of the critical approach adopted in this study provides a facility to

suggest to individuals alternative ways of interpreting their actions and defining their "reality"... It is by so providing individuals with the opportunity to reconsider the beliefs and attitudes inherent in their existing ways of thinking, that interpretive social theory can affect practice. Practices are changed by changing the ways in which they are understood. (Carr & Kemmis, 1986, p. 91)

The democratic mode of case study research disallows imposition of the researcher's interpretations on events in the research setting. While valuing negotiation of interpretations, this study considers that such interpretations need to involve a certain level of critique. Lather (1986) and Mezirow (1990) suggest that the way individuals interpret events reflects their beliefs about the world (reality) in which they live or prefer to live. Accordingly, such interpretations need to be critically examined because they may contain distortions of educational practice and taken-for-granted assumptions about knowledge and education. As Carr and Kemmis (1986) argue,

the recognition that educational theory must be grounded in the interpretations of teachers, is not in itself sufficient. For while it may be true that consciousness "defines reality", it is equally true that reality may systematically distort consciousness. (p. 129)

Carr and Kemmis (1986) argue for a research approach to "move the interpretive approach beyond its traditional concern with producing uncritical renderings of individuals' self-understandings" (p. 137). However, as Smith (1993) explains, the critique of educational practices is not critical in the negative sense. Rather,
the critique is ideological: it attempts to distil contextual processes which contribute to systematic distortion of subjective meanings.

In summary, case study methods are focused, flexible and interdisciplinary. They allow the researcher to closely study a particular situation and provide insights about events in the situation. Because of their interpretive nature, case study methods allow the researcher to critically examine the meanings of events in an instance in action rather than merely describe them. These characteristics make case study a particularly useful method for investigating educational change, and it was therefore adopted for this study.

4.5 Outline of the study

This section outlines the specific questions investigated in this study. A description of the plan of the study, the methods used to collect and analyse the data for answering the research questions, and ethical guidelines informing the research, are also provided and discussed.

4.5.1 Specific research questions

As stated in Section 4.1, the research question for this study was:

To what extent can everyday experiences be used as a vehicle for changing the learning and teaching of secondary mathematics in Malawi?

The review of the literature has shown that using everyday experiences in the classroom has the potential to change various aspects of student learning. However, the literature has indicated that students have difficulties recognising the presence of mathematical ideas in everyday-life situations. They have difficulties transferring their knowledge and skills from real life to school mathematics. Also, using everyday experiences in the classroom has enormous implications for the teaching of mathematics. This is because teachers need to have extensive knowledge and professionalism to enable them to facilitate the process of connecting everyday experiences and school mathematics.

Bearing in mind the above possibilities and constraints for using everyday experiences, and the complexity of change processes as reviewed in Section 4.3.1, it is important to consider the type of changes that might take place when everyday experiences are used in teaching secondary mathematics in Malawian schools. As described in Chapter 2, various Malawian educators and researchers have examined the possibility of providing a secondary education that connects mathematics and students' everyday realities. However, these proposals and discussions have not been supported by any empirical studies with students and teachers in Malawi. Information upon which these discussions have been based
has frequently relied on the use of questionnaires. As discussed in Section 4.3.2, there is an over reliance on questionnaires in research in developing countries. Additionally, the focus on system-wide features provides very little information about vivid classroom interactions, the forms of knowledge communicated, and constraints and realities of schooling at the chalk face.

This study was therefore designed to provide more insights about the above issues and to answer the following specific questions. How does the use of everyday experiences affect:

- students' attitudes to, beliefs about and knowledge of mathematics;
- students' participation in mathematics learning; and
- teachers' classroom practices and their views about mathematics teaching?

Case study methods involving students and teachers in two schools in Malawi were used to address these questions. By conducting the study over an extended period of time and using a variety of data collection methods, it was anticipated that change in student learning and teachers' teaching practices could be adequately investigated.

4.5.2 Overview of the study

The research took the form of a case study, carried out in two Malawian schools — one Distance Education Centre and one secondary school. The research involved three teachers. One of the teachers taught Form 2 mathematics at the Distance Education Centre and the other two taught Form 2 and Form 4 mathematics at the secondary school. In order to gain a deeper understanding of change in mathematics learning and teaching, and the context in which this change takes place, I also taught mathematics together with the teachers in their classrooms.

The study was carried out in Malawi over a period of about five months from April to October 1997. Conceptually, the study comprised of three phases: the preliminary phase, the teaching and reflection phase, and the concluding phase. Figure 4.4 shows the study time frame and the activities involved in each of the three phases.
<table>
<thead>
<tr>
<th>Phase</th>
<th>Period</th>
<th>Activities</th>
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<tr>
<td>PRELIMINARY PHASE</td>
<td>23 April to 15 May 1997</td>
<td>• Sought ethics approval from Deakin University</td>
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<td></td>
<td></td>
<td>• Contacted schools &amp; selected teachers in Malawi</td>
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<tr>
<td></td>
<td></td>
<td>• Administered the first student questionnaire to nearly 700 students in Forms 2 &amp; 4</td>
</tr>
<tr>
<td>TEACHING AND REFLECTION PHASE</td>
<td>16 May to 27 August 1997</td>
<td>• Involved teachers in planning, teaching, observing &amp; reflecting on more than 70 lessons</td>
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<td></td>
<td></td>
<td>• Conducted occasional informal interviews with students &amp; collected students’ lesson evaluations</td>
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<tr>
<td></td>
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<td>• Had a meeting with other teachers at each of the two schools</td>
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<td></td>
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<td>• Had informal meetings with four key education officials in Malawi</td>
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<tr>
<td>CONCLUDING PHASE</td>
<td>28 August to 10 October 1997</td>
<td>• Administered the final student questionnaire to nearly 700 students in Forms 2 &amp; 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Interviewed teachers</td>
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<td></td>
<td></td>
<td>• Collected students’ examination results</td>
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*Figure 4.4: Study Time Frame*

The teaching and reflection phase was the major component of the study in the two schools. In weekly meetings, the teachers and I planned lessons involving the use of everyday experiences. We taught these lessons and observed each other’s classes in turn. In one-hour weekly meetings, the teachers and I met to reflect on the lessons, to monitor any successes and identify problems experienced during the teaching process. These meetings provided opportunities for teachers to reflect on the effectiveness of the teaching activities.

The process of planning, teaching, observing and reflection on lessons constituted a documentation of the use of everyday experiences. This process enabled me to collect data about teachers’ views about mathematics teaching, the effects of these activities on their classroom practices and students’ attitudes to, beliefs about and knowledge of mathematics. At the end of the study, teachers were also interviewed in order to obtain detailed information about the effects of the intervention on their teaching practices and students’ learning. During the teaching and reflection phase, students were occasionally interviewed about how they felt about learning mathematics. They also completed short lesson
evaluations in which they were asked to comment on the activities of particular lessons.

In order to achieve a holistic understanding of the issues related to change in mathematics teaching and learning, brief meetings with other teachers (in the two schools) and key education officials in Malawi were held.

At the beginning of the study in the two schools in Malawi, a questionnaire was administered to students to document their attitudes to, beliefs about and knowledge of mathematics. A similar questionnaire was administered to students at the end of the study in order to determine the effects of the intervention on students’ attitudes to, beliefs about and knowledge of mathematics.

In addition, examination results were collected from the group of students involved in this study in 1997 and a corresponding group from 1996. The data from examination results was used to determine the extent to which the intervention affected students’ performance in mathematics examinations.

4.5.3 Data collection methods

Case study research uses a range of methods for collecting data. The methods used in this study were: participant observation, meetings and interviews, questionnaires, and document analysis. Students’ examination results were also collected. As described below, these data collection methods were complementary since they were intended to produce data that would achieve a holistic understanding of the question under investigation.

4.5.3.1 Participant observation

In participant observation, the researcher actively interacts with the context being observed. In this study, the aim of the observations was to document the implementation of the use of everyday experiences in the classroom.

As explained in Section 4.5.1, I assumed the roles of teacher and researcher. I believed that I could effectively monitor change by participating in the situation being changed. My participation in teaching was also consistent with my view of teaching, since I saw mathematics teaching and learning as inherently social and communicative activities necessitating the formation of “communities of practice” (Lave & Wenger, 1991).

In adopting a participant-observer role, a number of considerations had to be taken into account. Spradley (1980) clarifies the complexity of the participant-observer role as follows:

you will have to maintain a dual purpose: you will want to seek to participate and to watch yourself and others at the same time. Make
yourself explicitly aware of the things that others take for granted. It will be important to take mental pictures with a wide-angle lens, looking beyond your immediate focus of activity. You will experience the feeling of being both an insider and outsider simultaneously. As you participate in routine activities, you will need to engage in introspection to more fully understand your experiences. And finally, you will need to keep a record of what you see and experience. (p. 58, emphasis in original)

According to Ely, Anzul, Friedman, Garner and Steinmetz (1991), there are three forms of participant observation. These are: one in which the researcher is an active participant, the second in which they are a privileged observer, and the third in which they are a limited observer.

the active participant observer, the researcher has a job to do in the setting in addition to the research; the privileged observer is someone who is known and trusted and given access to information about the context; and the limited observer, ... observes, asks questions, and builds trust over time, but doesn’t have a public role other than researcher. (p. 44)

I assumed each of these roles at various stages of the study, depending on the opportunities and constraints on the research process as described in Chapter 5.

Having attended schools in Malawi, I had some familiarity with the culture of classrooms in which I expected to carry out my research. Ely, Anzul, Friedman, Garner and Steinmetz (1991) argue that familiarity with the research setting is advantageous as it allows the researcher to delve deeply into the research without having to do all of the preliminary work, such as learning a new lingo, becoming acquainted with the norms, and developing a level of comfort within the environment being studied. (p. 124)

Some commentators have stressed the need for qualitative researchers to assume the role of dispassionate recorder in an attempt to “disturb the process of social life as little as possible” (Burgess, 1985, p. 5). However, the role of a participant observer is reflexive and involves researchers studying themselves as well as other participants in a social setting.

This research was intervention. Hence a natural setting of classrooms cannot be claimed. However, although I was concerned that my presence would be threatening, I had anticipated that teachers and students would regard me as a colleague interested in improving the teaching and learning of mathematics.

It is difficult for a researcher to assume neutrality in research (Lather, 1986). I was interested in inquiry and knowledge production rather than preservation of truths. Consequently, my participation in classroom activities would be inquisitive: asking questions and reflecting on observed behaviours. As Carr and Kemmis (1986) put it,
observing a person’s actions ... requires an interpretation by the observer of the meaning which the actor gives to his behaviour ...
[Actions] can only be interpreted by reference to the actor’s motives, intentions or purposes in performing the action. To identify these motives and intentions correctly is to grasp the “subjective meaning” the action has for the actor. (p. 88)

Rather than devise a systematic checklist of behaviours to look for during observations, the aim was to capture behaviours in lessons that would express the intentions and values of teachers and students. This open-mindedness, together with a general description of the setting in which lessons were conducted, would provide a useful record of classroom activity to enhance the exploration of change in teaching and learning.

4.5.3.2 Meetings and interviews

Two principal uses of case study are to obtain the descriptions and interpretations of others. The case will not be seen the same by everyone. Qualitative researchers take pride in discovering and portraying the multiple views of the case. The interview is the main road to multiple realities. (Stake, 1995, p. 64)

I used interviews in order to supplement data obtained from various sources such as planning meetings with teachers, classroom observations, and my reflections on various aspects of the investigation in the two schools.

The study planned to involve teachers in reflecting on observations from classroom lessons. As this reflection was an ongoing activity during the research process, there was no need to conduct formal interviews with teachers. The only exception was at the end of the research process when semi-structured interviews were planned to systematically elicit teachers’ views about the effects of the intervention.

In reflective meetings with teachers, informal interviews with a “conversational tone” (Burns, 1994) were used. The motive in these conversations was to regard teachers as informants rather than respondents.

Rather than use pre-determined interview items, discussions with teachers focused on issues emerging from the research activities, from the participants’ perspective. In so doing, the discussions hoped to achieve a balanced representation of opinions on various issues pertaining to the study.

In order to make effective use of time, the discussions related as closely as possible to the aims of the investigation. At the same time, I wanted the discussions to be open to other issues, from the teachers’ perspective, that would turn out to be particularly relevant to the investigation.
Informal briefing meetings with other informants were planned in order to supplement data from classroom observations and discussions with teachers. As Burns (1994) suggests, "the case study investigator needs to be cautious about becoming too dependent on one informant and must use other sources of evidence for confirmatory and contrary evidence" (p. 319).

As explained previously, learning or teaching practices could change for reasons directly or indirectly related to the research intervention. However, I had anticipated that the extent of change would depend on the general context of teaching and learning. Accordingly, meetings were planned and held with other teachers (in the participating schools) and key education officials in Malawi in order to provide supplementary evidence that could enhance understanding of the issues related to change in mathematics teaching and learning.

I chose to tape record and make notes in order to record information from interviews and discussions. Various arguments have been presented for and against the use of tape recording. For example, Stake (1995) suggests that getting the exact words of the respondent is usually not very important, it is what they mean that is important ... . Rather than tape-record or write furiously, it is better to listen, take a few notes, to ask for clarification. (p. 66)

On the contrary, Burns (1994, p. 284) recommends that tape recording is the best method [of recording interviews], as the raw data remains for later study. Not having to take notes enables the researcher to take part in the conversation in a natural way.

Rather than rely on memory or notes written at the time of interview, I used a tape recorder in order to record detailed information, and at the same time, listen attentively to the informants and engage in an uninhibited dialogue. Although interview transcriptions are laborious and time consuming, they have the likely advantage of providing a fuller and more accurate record of what is said.

Some group interviews with students were planned. However, due to reasons explained in the next section, only a few of them were conducted.

4.5.3.3 Questionnaires

Questionnaires were used to collect information about students' views about mathematics, the context in which they were learning it and how they thought mathematics could be changed to make it more interesting for them. Questionnaires were also used to document the extent to which the research intervention had changed students' knowledge and perceptions of mathematics.

Questionnaires have traditionally been associated with quantitative research which aims at measurement and statistical analysis. As discussed in
Section 4.3.2, various researchers have indicated the inadequacy of quantitative methods in providing detailed understanding of schooling processes. However, it was appropriate to use questionnaires in this study for two main reasons.

First, due to the large number of students involved in this study, interviews with individuals or groups of students would require more time than was available. Conducting interviews with a selected sample of students would still be inappropriate as I could not ascertain in advance if any group of students would provide a balanced representation of students’ views about mathematics and the effect of the research intervention. In addition, this study could not escape the cultural and language problems associated with the use of student interviews in developing countries (Davies, 1997; Vulliamy, 1990a). Preston (1997) argues that there are occasions when face-to-face methods fail to achieve the disclosure of sensitive information as effectively as a survey... The anonymity of questionnaires may be more effective than in-depth interviews as a means of obtaining accounts of difficult personal experience. (p. 46)

Secondly, this study was inquiry-oriented: its aim was to make meaning, to collect information that would enable the case study to generate issues for inquiry rather than generalisation. Therefore, questions were designed to generate uninhibited responses and elicit qualitative accounts from students. This was achieved in two ways. A mixture of open and closed items were devised. Each closed question, such as “Do you think learning mathematics is important?”, was followed by a prompt to enable the respondent to give reasons for their opinion. In addition, in the final questionnaire, translated versions of questionnaire items were presented together with the English versions. This was done in order to clarify the questions and also give students the freedom to respond in a language they preferred. The aim was to achieve greater access to the meanings the students associated with the issues at hand. My familiarity with the native language was advantageous as it allowed me to capture the meanings in the students’ responses, although I was aware of the constraints associated with translating these to English. However, most students preferred to respond in English. In spite of the grammatical errors, the responses still preserved their intended meanings.

4.5.3.4 Examination results

As part of this study, I collected student examination results from the schools involved in the investigation. An analysis of students’ examination results was used to determine whether the research intervention had any effect on students’ performance in mathematics.
4.5.3.5 Document analysis

Documents are a valuable resource for enhancing the understanding of theoretical as well as contextual aspects of an investigation. A variety of documents such as books, administrative reports, correspondence, photographs, diaries and newsclippings can be an important source of information for a case study researcher. Although the credibility and accuracy of such documents always needs to be examined (Merriam, 1998), educational researchers in developing countries have recommended that they merit serious attention in research designs (Harber, 1997). This is because such documents contribute:

“flesh and blood” to our understanding of the often ambiguous and problematic nature of education in developing countries ... that is difficult with ordered, tidy and generalisable statistical data based on controlled sampling. (p. 114)

Documents provide information about phenomena that cannot be directly observed due to their sensitivity and geographical location. Harber (1997, p. 116) points out that documents such as newspapers in African countries provide realistic insights into what is actually happening inside schools as opposed to what official documents, government representatives, generalised statistical surveys ... say is happening.

However, publications relevant to African education are not abundantly available. When they do exist, bureaucratic and other structures limit their circulation. With respect to research conducted in developing countries, and given the inaccessibility of officially published material, secondary sources of information are accorded as much importance as primary data (Harber, 1997).

Malawian documents such as the Secondary School Curriculum Review Symposium Report (Ministry of Education & Malawi Institute of Education, 1995), and the Needs Assessment Survey for Secondary Education in Malawi (Chimwejene et al., 1995), provided useful information for describing the context of the study. Although containing scant information about change in mathematics education, these were the only accessible documents containing information about Malawian students’ views about the curriculum. Other documents such as mathematics syllabi, education policy documents, workshop reports, and newsclippings were collected since they would enrich the discussion of research findings.

4.5.4 General approach for the data analysis

Data analysis is a process of meaning making; it involves “bringing order, structure and meaning to the mass of collected data” (Marshall & Rossman, 1989, p. 112). Although not distinct, there are two commonly used strategies for analysing case study data. The first uses a pre-constructed analytical or category
scheme. Typically, such an analytical scheme consists of theoretical propositions that led to the conceptualisation of the study (Patton, 1990; Tesch, 1990; Yin, 1994). In this strategy, the aims of the study and specific research questions, guide the analysis. The researcher focuses on data that directly provides insights into the questions being investigated. The aim of this process is to enable the analysis to address the most significant aspects of the investigation.

In the second strategy, which has many parallels with the grounded theory approach (Glaser & Strauss, 1967) and ethnographic techniques (Merriam, 1998), the analysis begins with the data itself. The researcher does not begin the analysis with a predetermined classification scheme but allows themes or categories to emerge from the data through direct interpretation (Stake, 1995). By questioning, reading and rereading the data, the researcher gains familiarity with the data in order to develop a descriptive framework of the case (Yin, 1994). However, Yin (1994) regards this strategy as less preferable as it generally assumes that the study does not have any theoretical propositions. Hence Yin (1994) recommends that a combination of the two strategies be used in order to produce a compelling and full case study analysis.

The data analysis adopted for this study used both of the above strategies. At various stages of the analysis, I read through the data and kept track of themes and patterns that emerged. I also kept a record of hypotheses and interpretations I made as I worked through the data. The questions used in the research instruments (for example, student questionnaires and teacher interviews) guided the final stages of the data analysis since they directly addressed the questions of the investigation.

The analysis was also guided by the interpretive/critical approach adopted for this study. According to Mousley and Kortman (1996),

if a researcher assumes that the [data] tell the “truth” about actions or events; then the approach being taken is more positivist than interpretive. If another researcher analyses the data in terms of the socio-cultural [and] structural constraints under which the [subjects] act routinely, then a realist or critical stance is probably being taken ...

There is an assumption ... that there is something beyond the accounts that people give. (p. 43, emphasis in original)

The data analysis in this study aimed to describe the meanings participants gave to the research intervention, as well as to critically examine these meanings in order to determine the extent to which they were shaped by the social and political context of schooling.
4.6 Ethical considerations

Before undertaking data collection in Malawi, I submitted a research proposal to the Faculty of Education at Deakin University. This was accompanied by an ethics application to the Deakin University Ethics Committee. Both of these were approved in April 1997. In addition, I sought approval from the University of Malawi to carry out research in two schools in Malawi. As part of the negotiation process in schools, plain language statements (see, for example, Appendix 1) and consent forms were given to the participants. Informed consent was achieved by making the participants aware that their participation was voluntary. They were free to stop participating at any time during the study. The participants were made aware of the aims, methods, anticipated benefits and possible hazards of the study. Since English is a second language in Malawian schools, translated versions of the plain language statements and consent forms for students and their guardians were provided.

Ethical issues that arose during my interaction with the participants in the data collection process were also considered. Glesne and Peshkin (1992) note that ethics is not something that you can forget once you satisfy the demands of human subjects review board ... . Rather ethical considerations are inseparable from your everyday interactions with your others and with your data. (p. 109)

A number of dilemmas arose during the implementation of the study. The first concerned what Glesne and Peshkin (1992) term the dilemma of exploitation which arises when the researcher becomes immersed in the research.

Questions of exploitation, or “using” your others, tend to arise as you become immersed in research and begin to rejoice in the richness of what you are learning. You are thankful, but instead of simply appreciating the gift, you may feel guilty for how much you are receiving and how little you are giving in return. Take this concern seriously. (pp. 112–113)

The teachers’ commitment to the research was reciprocated in various ways. First, all the research activities concerned topics that the teachers were dealing with in their normal teaching plans. Secondly, as an active participant, I taught lessons and shared various teaching duties such as marking students’ work. In addition, weekly research meetings held with teachers provided opportunities for teachers to consciously reflect on their teaching practices and identify issues important for student learning.

Due to my role as researcher and agent of educational change, the dynamics of my intervention in the classroom setting posed dilemmas. Glesne and Peshkin (1992) caution that “[by] conducting the research, researchers may attempt to
right what they judge as wrong, to change what they condemn as unjust" (p. 114). Although I had not entered the research setting with the purpose of judging participants' behaviours, my interaction with students and teachers was not neutral. For example, as a result of our differing backgrounds, we had different beliefs and understanding of mathematics and effective mathematics teaching. Consequently, some of the teachers' actions in classrooms were not compatible with my values and understanding about mathematics. However, our differences in opinion about effective mathematics teaching were considered a normal and essential part of classroom practice. We discussed these differences in private, after lessons. Nevertheless, I felt guilty not intervening at what I considered to be the "right" time, that is, during the classroom situation. By being in the classroom, I felt responsible for students' learning and accountable to them. However, intervening in the classroom situation, though desirable, would not be ethical and would violate the teachers' privacy.

Although the participants were made aware of their rights in the research during the negotiation process, some students and teachers later acted in ways that indicated a misrepresentation of the ethical guidelines. At the Distance Education Centre, although my plain language statement to students' guardians did not ask them to pay anything, one guardian asked me how much money they were going to pay me for their children's participation in my research. It appears that due to the high demand for their children to be taught mathematics, and given the desperate shortage of qualified teachers at the school, this guardian associated the research activity with the private teaching commonly practised at the school. However, one teacher at the secondary school reported that some of her students wanted to know how much money they would be paid for being involved in my research. It appears that these students had envisaged that their participation in the research would be beneficial in terms of material needs rather than in relation to aspects dealing with classroom learning and general knowledge of mathematics. This reflected the differences in the needs of students in the two schools. While students at the Distance Education Centre desperately needed to be taught, those at the secondary school were already benefitting from being taught by mathematics teachers who were much better qualified than those at the Distance Education Centre.

At one meeting, the teachers at the secondary school said that "my ethics" had prevented them from discussing any aspects of the research with their colleagues. Clearly, specific details about research findings remained confidential and would only be made available to others after appropriate authorisation was granted. As I saw it, a discussion of the general concepts and values of the research was appropriate and could be shared with other teachers without posing any ethical
concerns. However, the teachers at the secondary school seemed to have understood the requirements of the ethics procedures as prohibiting any research-related discussions. Therefore, the implications of the ethics guidelines with respect to publication of research findings needed to be re-clarified to them.

The relationships I developed with the teachers enabled us to have some shared interpretation of the data. In order to accommodate their perspectives in the research, teachers were asked to comment on data from classroom observations, interview transcripts and my notes of meetings with them. However, in order to protect students' privacy, only collated summaries of student data (questionnaire responses, in particular) were given to the teachers.

In her recent discussion concerning ethical issues in mathematics education research, Sowder (1998) describes the researcher who has been working with a small group of teachers, providing them with rich opportunities to develop their understanding of mathematics teaching, and have formed relationships with them. In the process of writing about the changes observed in the teachers' teaching practices, the researcher is asked to consider the following:

- How do you deal with issues of confidentiality and anonymity, particularly since some of what you want to say is not something some of these teachers would like to read about themselves? (Sowder, 1998, p. 427)

At various stages in the research process and during the writing of the thesis, research findings were made available to the teachers for accuracy checks. In order to maintain confidentiality, pseudonyms have been used to identify the participants and the schools involved in the study. However, Sowder's concerns about the larger ethical issues confronting mathematics education research still stand, especially if they are considered together with the institutional constraints of engaging in research. While the teachers in this study had access to the discussions and conclusions I was making based on their data, it was difficult to achieve the same with their students. This was because of communication problems beyond the researcher's control. The later stages of the writing process was carried out in Australia, thousands of kilometres away from Malawi. It was difficult to communicate with most of the students involved in the study. At the time of writing the thesis, the Form 4 students had already graduated and were no longer members of the secondary school used in the research. Although most of the Form 2's were still in the schools where the research was conducted, getting the cooperation of these would be difficult since they were now in a different grade and were dealing with different teachers from the ones they had during the period the research was being conducted.
CHAPTER 5
DESCRIPTION OF THE STUDY

The research process described in this chapter was conceptualised as consisting of three phases: a preliminary phase, the teaching and reflection phase, and the concluding phase. The description of the research process in this way is appropriate since it characterises the major events that took place during the implementation of the study in two schools in Malawi.

5.1 The preliminary phase

The research took place in Zomba, a district in the Southern Region of Malawi. Typical of Malawi, Zomba is predominantly rural with only about 10% of its population living in the urban areas. Educationally, Zomba hosts four important institutions, namely, the University of Malawi's largest campus (Chancellor College); the Malawi Institute of Education, which coordinates primary school curriculum development; the Malawi National Examinations Board, which is responsible for setting and processing all primary and secondary school examinations; and Domasi Secondary Teacher Training College, which is responsible for training secondary school teachers in conjunction with the Faculty of Education at the University of Malawi. Zomba can be described as being at the apex of educational activity in Malawi.

This section describes the preliminary phase of the research which involved negotiating access to schools in Zomba, selecting teachers and administering the first student questionnaire. The administration of the first student questionnaire was carried out in the preliminary phase in order to collect background information about students before commencing the research intervention in the selected schools.

5.1.1 The schools

Zomba has seven government secondary schools, more than ten Distance Education Centres (DECs, see Chapter 2), and a number of small private secondary schools. For the purposes of this research, I was interested in working in one government secondary school and one Distance Education Centre.

Prior to commencing data collection in Malawi, I submitted a research proposal and an ethics application to Deakin University. Both of these were approved in early April 1997. In addition, I successfully sought approval from the University of Malawi to carry out research in Zomba schools. This was granted in early May
1997. Subsequently, my former Head of the MAMSTIP Department wrote a letter to principals of potential schools, informing them of my research, and requesting their support and solicitation of Form 2 (Junior Certificate) mathematics teachers who would be willing to participate in the research. In her letter, my former Head of the Department mentioned that the research was about alternative approaches to teaching mathematics and was intended to benefit both the researcher and the teachers, through active participation and involvement. She emphasised that the research would broaden teachers’ perceptions of teaching and enhance students’ enthusiasm in learning mathematics.

Four secondary school principals promptly responded to my Head of the Department’s letter and nominated teachers who would be interested in participating in the research. When I visited the schools, two DEC principals said they had not had time to respond. Another DEC principal said he had not received any letter. Nonetheless, all the principals (verbally) expressed interest in their schools being involved in the research and suggested names of teachers who would participate in the research.

Despite access having been granted by seven schools (three Distance Education Centres and four secondary schools), because of my research design, I decided to select only two schools, namely one Distance Education Centre and one secondary school. For convenience and confidentiality, the two schools selected will be referred to here as the DEC and the SEC, respectively.

5.1.2 The teachers

My initial contact with the teachers at the secondary school (SEC) was made when I visited the SEC principal to obtain her written consent for her school’s involvement in the research. The nominated teachers had already been informed by the principal that I would be visiting the school. Hence, after meeting the principal, I was introduced to the teachers. The two teachers, both female, were the Form 2 and the Form 4 mathematics teachers. For reasons of anonymity, these teachers will be referred to here as TS2 and TS4, respectively.

At this initial meeting, I introduced my research to the teachers, TS2 and TS4, who, after reading the plain language statement describing the research, showed a significant enthusiasm for the research. However, TS2 wondered whether I would also be taking part in teaching, and wanted to know what would happen if one of them withdrew from the research. I explained that, as part of the research plan, I would also be teaching with them, adding that they were free to withdraw their participation at any time. At this meeting, TS2 seemed to be more curious and interrogating than TS4. She expressed interest in the continuation of
the research, that is, she wanted the ideas of the research to continue to be explored after the conclusion of my study. I was rather worried about the extent of TS4’s participation in the research since she sought no clarification of any of the issues being raised by her colleague. Also, although she was nominated by the SEC principal, she did not satisfy one of the requirements for participants in the research, that is, that they would be teaching mathematics at Form 2 level. After consulting with my research supervisors, I retained TS4’s participation in the research. This decision proved appropriate since, in the longer term, TS4’s participation enriched the collaborative nature of the research. Her contributions yielded a rich perspective to the research process and issues about the context of mathematics instruction in Malawian secondary schools.

Access to the Form 2 mathematics teacher at the DEC, who was male and will be referred to here as TD2 for confidentiality, took more time. I visited the DEC principal to obtain consent for his school’s involvement in the research. The principal quickly read through the plain language statement and nominated himself and another teacher (TD2) to participate in the research. TD2 had been away because he had to accompany the DEC football team at an inter-school soccer competition. A few days later, I met briefly with TD2 and the DEC principal to describe the research plan and give them a plain language statement and consent form. While both of them showed interest in the research, I was rather doubtful that the DEC principal would totally commit himself because of his administrative role. I therefore invited the principal to act as an observer rather than a full participant. The principal agreed to this arrangement.

To summarise the process of getting access to the teachers in the two schools, it is clear that things had not turned out as I had anticipated. In the SEC, I managed to get the cooperation of two teachers (TS2 and TS4), with the choice of one of them not being fully compatible with the requirements of my research protocol. In the DEC, although I had the cooperation of two teachers, the DEC principal silently withdrew his participation due to his administrative and teaching load. Hence I was only left with one teacher (TD2) at the DEC.

5.1.3 The students and their classes

Having gained access to the schools and teachers, I had little control of the students and classes with whom I would work. However, the intention was to carry out the study in two schools with teachers at the Form 2 level and their classes. The Form 1 and Form 3 classes were excluded from the study since they were being taught by student teachers from the University of Malawi and the Teacher Training College. I wanted to conduct the research in classes whose teachers were permanent members of staff in the schools.
5.1.3.1 At the DEC

This research involved very large classes, particularly at the DEC where 329 students were in the Form 2 class. As described in Chapter 2, class sizes are large because, out of more than 100 000 primary school graduates, less than 10% gain a place in the secondary school education system. Over half of the remaining graduates enrol in Distance Education Centres (DECs).

At the DEC, there were more than 1000 students from Form 1 to Form 4, with only 18 teachers. The DEC operates in buildings which belong to a primary school. Consequently, DEC students are able to attend their lessons only in the afternoon hours, after the primary school pupils conclude their sessions. The primary school classrooms were designed to accommodate about 60 to 70 students each. The Form 2 DEC class of 329 students was divided into two streams each consisting of about 160 students. Given this extraordinary space limitation, overcrowding in the DEC classes is evident. Moreover, because of scarcity of desks and chairs, more than 80% of the students are forced to sit on the floor, squat or stand while attending lessons. In an effort to create a slightly more “comfortable” environment for students, teachers at the DEC often hold their lessons outside the classroom, under a tree (see Appendix 2).

5.1.3.2 At the SEC

The SEC had a total student population of about 700, with more than 25 teachers. There were 189 students in Form 2 (TS2’s class) and 158 students in Form 4 (TS4’s class). TS2 and TS4’s classes were divided into three streams, with each stream consisting of about 50 to 60 students. The classrooms in which these students were learning had desks, chairs, class noticeboards, a good blackboard and electricity. In relative terms, students at the SEC clearly enjoyed a better resourced learning environment than those in the DEC (see Appendix 3).

5.1.4 Background information about the teachers

After gaining access to schools, I held informal discussions with teachers to find out more about their educational backgrounds and the conditions in which they teach mathematics. TD2 and TS4 had training in primary and secondary teaching, respectively, while TS2 had no formal training in teaching. TS2 and TS4 had done mathematics up to university level, while TD2 only had an equivalent of an O-Level qualification in mathematics.

Table 5.1 presents a summary of the background information about the teachers and the conditions in which they taught.
### Table 5.1: Teachers' Background and Teaching Conditions

<table>
<thead>
<tr>
<th>Teacher</th>
<th>School &amp; Year Level</th>
<th>Teachers' background</th>
<th>Teaching conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD2</td>
<td>DEC Form 2</td>
<td>• Primary Teacher trained&lt;br&gt;• Form 4 (O-level) mathematics (4 years of secondary schooling)&lt;br&gt;• No secondary teacher training&lt;br&gt;• 4 years teaching experience (2 years at DEC)</td>
<td>• 329 students in 2 streams&lt;br&gt;• Classrooms too small &amp; very little furniture&lt;br&gt;• Lessons often conducted under a tree&lt;br&gt;• Teaching load 10 forty-minute &amp; 5 one-hour periods per week</td>
</tr>
<tr>
<td>TS2</td>
<td>SEC Form 2</td>
<td>• Bachelor of Science&lt;br&gt;• Second year university mathematics&lt;br&gt;• No secondary teacher training&lt;br&gt;• 2 years teaching experience at SEC</td>
<td>• 189 students in 3 streams.&lt;br&gt;• Classrooms relatively well furnished&lt;br&gt;• Teaching load 21 forty-minute periods per week</td>
</tr>
<tr>
<td>TS4</td>
<td>SEC Form 4</td>
<td>• Bachelor of Education&lt;br&gt;• Four years of university mathematics&lt;br&gt;• 4 years teaching experience (2 at SEC)</td>
<td>• 158 students in 3 streams.&lt;br&gt;• Classrooms relatively well furnished&lt;br&gt;• Teaching load 21 forty-minute periods per week</td>
</tr>
</tbody>
</table>

#### 5.1.5 The first student questionnaire

As an initial main step in the research process, I administered the first student questionnaire. The first student questionnaire was used to obtain information about students' interest in mathematics, the importance they attached to learning it, and how they thought mathematics could be changed in order to make it more interesting for them. In getting this information, I hoped to document students' attitudes to, beliefs about, and knowledge of mathematics. I planned to use this information to determine the effectiveness of the research intervention. The questions used in the first questionnaire are shown in Appendix 4.

#### 5.1.5.1 Trialing of the questionnaire

Due to time constraints, I did not have sufficient time to trial the questionnaire in Malawi before commencing data collection. However, while completing my research proposal in Australia, I conducted a small pilot with year 9 and 10 students in two Victorian schools. While piloting the questionnaire with Australian students could provide valuable information in terms of establishing the clarity of the questions, this process could not yield the same results as would be obtained if the questionnaire was trialed with Malawian students. This was due to language and general differences in school conditions, as well as the expectations and realities of students. Hence after gaining access to schools in
Malawi, the teachers and I discussed the questionnaire items. While there was general agreement that the questions were appropriate, TS2 suggested that we add another item to the list and pilot the questionnaire on a selected sample of students to check if “we were getting the right information” (Fieldnotes, 9/5/97). This discussion of the questionnaire was also aimed at ensuring that the teachers developed the sense of ownership and collaboration proposed in the research.

I had expected that the DEC teacher (TD2) would also comment on the questionnaire. However, TD2 did not feel too concerned about the appropriateness of the questionnaire items in the form they appeared after revision by the other teachers in the SEC. This apparent lack of input, though rather discouraging, was advantageous for my purposes. I wanted to use the same instrument at both schools in order to allow for some form of comparability of students’ responses during the data analysis.

5.1.5.2 Administration of the questionnaire

The first student questionnaire was administered at both schools at the beginning of the research process in May 1997. The conditions under which the administration proceeded were different in the two schools. This resulted in different response rates.

At the DEC, I had prepared about 350 copies of the questionnaire to be completed by Form 2 students at the DEC. With the help of their teacher (TD2) and the DEC principal, I managed to distribute copies of the questionnaire to about 240 Form 2 students. Prior to this, the DEC principal assured the students that there were enough copies for everyone. This was done because students had a tendency to “fight” amongst themselves for copies of any document (for example test papers or handouts) especially if they were not sure that there would be enough for each of them. We could see a sigh of relief when each student received a copy of the questionnaire. Before completing the questionnaire, I assured the students that it was not a test, and requested that they respond to the questions in the way they best understood them. In addition, I mentioned that they were free to be anonymous if they wished.

I had expected that the task of completing the questionnaires would be handled with minimum formality. However, the DEC principal seemed to have taken the task rather too seriously. He made sure that he was present in the classroom until students had finished filling in the questionnaires. This happened in spite of my having ensured that the activity was as informal and unintrusive as possible (for example by waiting outside the classroom instead of staying in the room all the time). While I considered the principal’s action as a misrepresentation of the
partnership of the research, he, on the other hand, as school principal, wanted students to lend their full cooperation to my research. Without this I would not have managed to obtain a high questionnaire return. In spite of all this formality, a good proportion of students did not hand in their questionnaires. We received completed questionnaires from only 195 out of 240 students.

At the SEC. During my initial contact, TS2 and TS4 showed a lot of interest in the research. However, I became rather worried about the extent to which their students would demonstrate similar enthusiasm. This concern arose when the deputy principal of the SEC said something to the effect that, "They just come and go". This remark was made in reference to the many researchers from educational institutions who had previously conducted research surveys or short investigations at the SEC. The remarks from the deputy principal indicated that he saw little benefit in his school’s involvement in research activities. By implication, this included my research. I did not discuss this concern with TS2 and TS4 for fear of entering the debate too early. Technically, I was still negotiating access to the school. However, this lack of research impact seems to have been reflected in the way some students responded to the research activity. While students showed interest in the research during preliminary introductions and completion of consent forms, only 126 out of 158 students in Form 4 (TS4’s class) completed the questionnaire. TS4 seemed to possess a degree of authority which resulted in more of her Form 4 students returning completed questionnaires. Only 54 out of 189 students in Form 2 (TS2’s class) completed the questionnaire.

In both schools, success in getting students to complete the questionnaire depended more on their teachers’ support than on my negotiations with students.

5.2 The teaching and reflection phase

The teaching and reflection phase constituted a major part of the research process in the two schools. This phase consisted of four main activities which are described here as following a cycle of planning, teaching, classroom observation and reflection sessions. On the whole, the planning sessions preceded the teaching, observation and reflection sessions. Although described separately, these sessions occurred interactively.

5.2.1 Planning sessions

The teachers and I used the planning sessions in order to identify everyday experiences that could be used when teaching particular topics in the mathematics syllabus. The aim was to discuss ways of connecting these experiences to the mathematics content.
At the beginning of the study, TS2 and TS4 had already made teaching plans in the form of "schemes of work". These advance plans had been made and submitted to their Head of Department in accordance with the school’s policy which required teachers to:

keep up-to-date school records for which they are responsible. These include ... schemes of work, lesson notes and mark books. These documents shall be available in the school for scrutiny at any time (Ministry of Education, 1997, p. 8, emphasis added).

TS2 had planned to teach the following topics: the Cartesian Plane, Straight Line Graphs, Direct and Inverse Proportion, Reciprocals, and Pythagoras Theorem. All of these were topics in their recommended textbook (Gunsaru, 1991). TS2 had planned to refer to this textbook when introducing lesson topics and setting class exercises. Similarly, TS4 had planned to teach the following topics: Direct and Inverse Variations, Joint and Partial Variations, Mensuration of Solid Shapes, the Cosine Rule, and Bearings and Distances. These were topics in their mathematics textbook (Gunsaru & Macrae, 1991).

At this early stage in the study, it became clear that I had little control of the content. Some of the content, for example, the "use of four-figure tables", "logarithms", and "inequalities", did not lend itself to the use of everyday experiences, at least in the way it was expected to be taught. For example, the Malawi Junior Certificate Mathematics Syllabus provides the following teaching suggestions when teaching the topic "use of tables":

Give pupils a lot of exercises on estimating square roots of more complicated numbers,... . Pupils should do a lot of exercises of this nature before handling tables. These will help them to avoid looking at the wrong tables and also to solve problems associated with finding roots of numbers which are less than 1. After thorough work on estimation and fixing of the decimal point, show pupils how to use the tables. (Ministry of Education, 1987, pp. 19–20)

The justification given for learning about the use of tables is a mathematical one: to enable students to solve mathematical problems involving squares and square roots. There are no suggestions in the syllabus about how this topic could be taught in order to relate it to students’ everyday experiences. In some topics such as probability at Form 4 level, no teaching suggestions are given.

It became clear that I could only work within the teachers’ existing plans and circumstances. Rather than plan “complete” lessons which teachers could then follow, my role was to provide some input in terms of items that would be used to link the topics with everyday experience and stimulate active participation and discussion among students. An example of the type of teaching plans made for some topics is shown in Appendix 5. An expanded version of a teaching plan on the topic of probability is shown in Appendix 6. My role in lesson planning
was to provide some suggestions with the aim of opening up issues to be explored further. In general, the aim was to provide stimulus to lessons teachers would plan or already had planned.

At the beginning of the study, the teacher at the DEC (TD2) complained that he experienced difficulties planning lessons on his own since he did not have enough reference materials. This lack of teaching materials was compounded by the fact that TD2 had no adequate training to teach at the DEC level. Hence the planning that took place with TD2 took account of the fact that we needed more time to discuss the mathematics content to be taught. Subsequently, the aims of the research became subsidiary. For TD2, revising his knowledge of mathematics took a substantial proportion of the planning time. To this end, TD2 often expected me to plan tests and most of the lessons (Fieldnotes, 22/5/97, 24/6/97).

Planning meetings took place once a week after classes. The meetings usually took place at school and sometimes at the teachers’ homes. Meetings held at school took about an hour. Meetings at home were short and usually took about 15 minutes since these were occasions when I would give the teachers some lesson plans for their consideration.

The decision to have short planning meetings was made after I realised that the regular weekly meetings did not provide sufficient time to plan for all the lessons that would take place the following week. This was often the case since teachers would often finish a topic during the middle of the week and begin another topic without having time to consult each other. Consequently, instead of waiting for the regular weekly meeting, short meetings with the teachers at their homes enabled us to discuss suggestions that could be included in the lesson plans.

Brief notes of planning meetings were made soon after the meetings. I made extended reflections on them later when I had more time. I kept records of lesson tasks and teaching plans shared with teachers.

In general, we wanted to plan lessons together before teaching them. However, it became increasingly difficult to hold weekly planning meetings. The following notes from my research diary best capture the frustration I experienced with the planning process.

I haven’t been able to organise as many “proper” planning meetings as I wanted. Both time and content have been a problem. My initial plans were to spend two days at the DEC and two days at the SEC. I had hoped to have just one class to deal with in each of the schools. I haven’t been able to meet this plan due to the demands of the school situations. Instead, I have had to teach and make observations in all the Form 2 and Form 4 classes belonging to the three teachers. Most of the small planning with the teachers has been “on-the-spot”, as the situation allows. (Fieldnotes, 27/7/97)
On the whole, planning took place spontaneously rather than systematically occurring according to schedule. Some planning occurred in the teaching situation itself, especially at the DEC since TD2 would often require help when answering questions from students.

5.2.2 Teaching sessions

The main aim of the teaching sessions was for the teachers and I to teach mathematics lessons based on the plans we had made. Due to reasons explained below, a majority of these lessons did not take place according to the purposes they were intended for. However, my participation in the teaching sessions enabled me to gain a greater understanding of the context of the study and teaching conditions that would facilitate the use of everyday experiences in teaching mathematics.

5.2.2.1 An overview of the lessons

TS2 and TS4 each had 21 forty-minute periods per week while TD2 had 15 periods which consisted of 5 one-hour periods in the mornings and 10 forty-minute periods in the afternoons. My original plan was to spend two days a week either teaching or observing lessons at the DEC and another two days a week at the SEC. However, the lesson timetables in the two schools often clashed. Hence I decided to use two-half days a week teaching or observing lessons at the DEC and, because TS2 and TS4 had a bigger teaching load than TD2, I spent three days a week teaching or observing lessons at the SEC.

5.2.2.2 A lesson based on the use of everyday experiences

A description of one lesson is provided here in order to give an example of how the use of everyday experiences manifested itself in the classroom.

Lesson topic: Averages. TS2 and I planned this lesson as a revision of the topic "Averages" in Form 2E at the SEC. At the time of this lesson, the Form 2E students had already had two lessons about the topic in which they had been introduced to averages, and had also done a number of computational problems involving the terms mean, mode and median.

Aim and procedure of the lesson. In this lesson, we formulated a problem which had the potential to explore students' mathematical reasoning as well as to use an everyday context to stimulate dialogue and reflection among students. This lesson was also planned because of numerous requests from Form 2 students to be given problems of the same style (multiple-choice) as they would expect to answer in their national examinations at the end of the year. Students wanted
this type of question in order to practise for the coming examinations. The
textbooks they were using did not have any multiple-choice exercises since these
textbooks were written before the Malawi National Examinations Board had
introduced multiple-choice examinations in schools.

We asked students to answer the multiple-choice question shown in Figure 5.1.

| According to the Mingale Secondary School Football Association, during the match between Mingale and Malapa schools, the average number of “free kicks” awarded was 10. The possible number of “free kicks” awarded for each school was: |
|---|---|
| (a) Mingale: 7; Malapa: 13 |
| (b) Mingale: 8; Malapa: 12 |
| (c) Mingale: 9; Malapa: 11 |
| (d) Mingale: 10; Malapa: 10 |

Which of the above is correct? Why?

*Figure 5.1: Multiple-choice Question on Averages*

I wrote the question on the board. Before asking students to answer the question,
we spent about 10 minutes discussing the context of the problem. There was a lot
of excitement about the problem as it was framed in the context of a football
match which had taken place at their school during the previous weekend. The
class discussed football terminology such as “free-kicks” and “penalties”. This
was important since, although most students were familiar with the game of
soccer, some students could not distinguish between free-kicks and penalties and
the conditions under which these are awarded to a team.

Students then proceeded to answer the question in their exercise books. TS2 and I
went around the class to check their solutions. We kept a record of the range of
and reasons for the options the students had chosen. Out of a class of 58
students, more than half chose option (d). Only about 10% of the students said
all the options were correct while the rest of the students chose one of the options
a, b, or c. During discussion time, we asked students to explain their choices. The
lesson rapidly developed into a debate between students who had chosen option
(d) and those who had said all the options were correct. Each student, including
those who were usually inactive, wanted to defend their choice. In his defence,
one student grabbed a piece of chalk from my hand, went to the front and wrote
on the board: “d is my best answer” (Fieldnotes, 2/7/97). At the end of the 40-
minute lesson, most of the students agreed that all the options were correct.
However, a number of students remained unhappy about the class decision and
wanted further explanations.
At the end of the lesson, we asked students to describe their feelings about it. Immediately after this lesson in Form 2E, TS2 suggested that we should have included a fifth option: (e) all are correct. She had observed that some students had difficulty recognising the significance of the word “possible” in the question. TS2 therefore felt that adding a fifth option would have avoided the confusion. When teaching the same lesson in Form 2N and Form 2W, TS2 tried to alert students to the significance of the word “possible”. This hint appreciably reduced the level of debate among students in the two classes.

5.2.2.3 Why describe this lesson?

The above review of the lesson on averages has been provided because it was one of the few lessons in which it was possible to collect data that would address some of the critical issues in my study. The reason for providing a review of the lesson taught by me is not to claim this as being the most successful lesson nor to undervalue other lessons including those taught by the teachers. The intention, however, is to emphasise the fact that I had little control of the lessons in which I was not the one teaching in spite of the collaborative planning that had taken place. While collaborative planning established some agreements on the procedures to be used in the lessons, decisions during the actual teaching process remained at the discretion of the teachers. As a researcher, I was more interested in viewing the progress of the lessons from a research perspective, while teachers, because of their expected role in the classroom, were focusing more on the extent to which the lesson covered the mathematics content on the syllabus.

5.2.2.4 Typical lessons

A common pattern of the lessons taught by the teachers followed the “exposition-example-exercise” pattern, with a substantial amount of time spent on marking or reviewing assignment exercises. This pattern was typical of most lessons, including the ones in which we had planned and outlined suggestions about ways of making students more engaged in discussions about the connections of the concepts with everyday experience. Typically, teachers would introduce a topic and rapidly move on to the mathematics content without exploring other questions that would be prompted by the use of an everyday example. For example, in a lesson about averages, while TS2 had collected information about students’ shoe sizes and used it to formulate exercises related to the concepts of “mode”, “mean” and “median”, other questions that would lead to a discussion about why a knowledge of averages is important for shoe manufacturers were not asked. Consequently, my role in lessons was to initiate questions or discussions. However, such initiatives were sometimes ignored by
the teachers and occasionally derided by some students, who seemed to regard answers to some questions as obvious.

I had intended to be a participant observer in the teachers' lessons. However, my role of observer at the DEC greatly diminished since TD2 often required assistance while teaching. This was due in part to the large number of students he was teaching (see Appendix 2 and Table 5.1).

5.2.3 Classroom observations

The primary aim of observing lessons was to document the implementation of the use of everyday experiences in terms of the teaching plans I had made with the teachers.

In observing lessons, I had intended to make use of an observation schedule (see Appendix 7) to record as much information as possible regarding various aspects of lessons such as the classroom setting, the topics and outline of lessons, and examples of everyday experiences used in lessons. In addition, I had intended to record information about how teachers used everyday experiences in the teaching activities. During observations, I occasionally took photographs of the classroom in order to capture the physical context in which the lessons were taught. The ultimate aim of the observation sessions was to record information about what happened in the lessons in order to allow me to describe the teaching context in which everyday experiences were used.

However, several factors affected the amount and quality of the recorded information during the observation process. Four of these are described below. Firstly, due to lack of time between the planning and implementation of the research in Malawi, the observation schedule was not trialed. Hence before implementing the research in Malawi, I did not have the opportunity to update my observation skills to enable me carry out observations that would produce systematic records of classroom events that could constitute data amenable to extensive and meaningful analysis.

Secondly, as mentioned in Section 5.2.2, very few lessons took place in the way I had expected. Due to the nature of the mathematics topics the teachers were dealing with, very few lessons actually involved the use of everyday experiences. In addition, for the few that did, the use of everyday experiences played a very marginal role. In designing the study, I had anticipated that the use of everyday experiences would encourage active participation of students in terms of enabling them to ask more questions, rather than just listening. I had also expected teachers to be less directive, that is, to follow up students' responses rather than force students to follow the teachers' explanations. However, during the teaching
sessions, there were occasions when I believed that follow-up actions could have been used but were not used. This occurred mostly because teachers seem to have been adhering to their normal plans as reflected in their comments when they observed some of my lessons. As a result, my observations of these lessons often did not record in detail what had happened but rather consisted of comments and reflective attempts to make meaning from classroom events. For example, I recorded suggestions I had made about follow-up actions or questions which teachers could have used in response to students' comments in order to stimulate dialogue and active participation of students in the classroom.

Thirdly, due to my role as a participant observer, I experienced problems when observing some lessons, especially TD2's. This was because he often required professional support during teaching sessions. At times, he would redirect students' questions to me when he was not sure of the responses he had given. This had the effect of disrupting the observation process since I had little time to accurately observe and record what was happening. However, these disruptions had some desirable consequences since they enabled me to provide some stimulus to the lessons. Due to these teaching conditions, I became more of a co-teacher and less of an observer at the DEC than at the SEC, although the content of observations was similar in both cases.

Lastly, very few classroom observations were made on the lessons in which I was the one teaching. The teachers were given observation schedules and diaries for recording their comments about the lessons. However, they rarely used the schedules but preferred to jot down comments in their diaries instead. However, the diaries were not completed regularly and were not very detailed.

The conditions under which the observation process took place as described above resulted in inadequate classroom observation data being collected. However, I completed a research journal on a regular basis in order to record insights, reflections and reactions to events in the field. These included recollections about what happened in the teaching sessions, including, for lessons in which I was the one teaching, why I did what I did.

Although consisting of insufficient observation data, both the observation schedules and the research journal were useful tools that provided some information upon which to describe the implementation of the research at the classroom level.

5.2.4 Reflection sessions

A major component of the research process involved reflecting on lessons as well as other issues emerging from the interaction with the participants. In order to
achieve a broader perspective of teaching and learning, the reflection process involved other informants from both within and outside the two schools.

5.2.4.1 Reflective meetings with TD2, TS2 and TS4

I organised meetings with teachers during which we reflected on lesson observations, the aims of the research and issues that emerged about the educational context in which the teachers were working.

Meetings with TS2 and TS4 took place after school hours about once a week at their school for about an hour and half to two hours. Meetings with TD2 were usually shorter and took place for about an hour at the DEC or at TD2’s home. Meetings with TS2 and TS4 often generated vigorous discussion, with the teachers keen to explore issues further. Hence I was able to take a more subsidiary role, mostly acting as a guide. However, meetings with TD2 often lacked stimulus, with me playing the role of initiator of most issues. All meetings were tape recorded and summaries of key issues discussed in these meetings were prepared and given to the teachers for comment.

The agenda for discussions arose from notes of previous meetings, recollections of classroom episodes and comments from students about lesson activities. Of particular importance to the research was a discussion about the conceptual framework underpinning the use of everyday experiences. Recollections of classroom episodes provided a useful stimulus to discussion about the rationale for using everyday experiences. Linking the discussion to observed classrooms incidents provided teachers with opportunities to gain a personal understanding of the consequences of the teaching approach on learners and themselves.

Although classroom episodes provided a useful stimulus for discussions, there were occasions when reference to these became rather sensitive, particularly during meetings with TS2 and TS4. For example, there were occasions when we had more interesting episodes to report from TS2’s class than from TS4’s. While sharing these episodes enriched discussions, I often felt that it had the potential to make the other teacher feel as though her teaching efforts were not as effective. Hence, I often felt obliged to provide a balanced account of classroom episodes.

Teachers’ concerns about the research activities were also discussed. Not surprisingly, teachers found the activities demanding and time consuming. TS2 and TS4 felt that they did not have enough time to record comments in their diaries, although they appreciated the value of keeping a diary as a tool for aiding reflection about their practice. The research activity seemed to have significantly affected TD2 teaching pattern. Half way through the data collection process, TD2 found the activity tiresome and considered reducing the number of
teaching hours, but rescinded his decision after reading a summary of students' comments on lessons. Students felt very positive about his teaching.

While reflective meetings were intended primarily to be a source of data for my research, they also provided an opportunity for teachers to encourage each other and share ideas for dealing with individual classroom situations.

5.2.4.2 Students' evaluations of lessons

Halfway through the data collection process, students completed evaluations in which they were asked to comment on the activities for the lessons. These evaluations were varied in nature. Some of them were specific in that students were asked to comment on a particular lesson such as "averages" as discussed in Section 5.2.3. Other evaluations were more general and required students to describe things they had done in previous lessons which showed that mathematics was interesting or useful to their everyday lives.

I had originally intended to hold reflective meetings with small groups of students, in order to probe them about their feelings about lesson activities, at several stages in the data collection. A few of these meetings took place and were tape recorded. However, this process provided data that posed immediate analysis problems. Most students who participated in the small group discussions opted to use their native language (Chichewa) in order to express their ideas more fluently. Transcribing these discussions would have been very time consuming. In addition, translating these would not preserve the students' intended meanings since some Chichewa words do not have direct English translations. Hence, I collected students' written comments about their learning in addition to some tape recorded discussions with groups of Form 4 students who were more fluent in English. These data were used as supporting information in the analysis of the data from the student questionnaires.

5.2.4.3 Meetings with other teachers and education officials

A month before completing the data collection process in Malawi, the teachers and I organised informal meetings during which we briefed other teachers in the two schools about our research. These meetings were of about 30 minutes duration. The aim of these meetings was to collect other teachers' comments about the research and the value they would attach to the use of everyday experiences. In the longer term, we wanted to extend our dialogue about the appropriateness of our research to the wider school community.

TS2 led the meeting at the SEC, at which 8 teachers belonging to the science department were present. I led the meeting at the DEC since TD2 said he did not
want to appear to know more than his colleagues. In addition, TD2 felt that his colleagues would not be interested in the research ideas. However, after a long discussion with him about the need for other teachers to contextualise their teaching and work more collaboratively in order to improve the learning situation in the DEC, he saw the usefulness of briefing other teachers.

The information from informal meetings with teachers provided supplementary data which formed the basis of my reflections about collaborative research and the role of the school context in educational change.

Towards the end of the data collection process, I had individual meetings with four education officials in Malawi: an examiner at the Malawi National Examinations Board, an education specialist at the University of Malawi, a curriculum developer at the Malawi Institute of Education, and a distance education specialist at the Malawi College of Distance Education headquarters. The aim of these meetings was to brief them about my research and seek their views on issues emerging from my study in the two schools. Views from these education officials were solicited in order to gain a broader perspective of issues regarding assessment and changes in mathematics education in Malawi. Discussions with the officials took place at their offices and were tape recorded. Transcripts were prepared and given to the officials for alterations. Consent to use their data in my thesis was granted.

5.3 The concluding phase

After having been in the two schools for more than four months, I was confident that I had gathered enough data to allow me to address the questions under investigation. I could see some themes emerging in the reflections I was making in my research diary.

The students had only a few weeks before writing their examinations. Hence the pressure of the examination began to interfere with the teaching process. Most Form 4 students stopped attending classes as they needed more time for independent study. The teachers started reviewing mathematics questions from previous examination papers. I became more uncomfortable with the teaching styles the teachers were using since they mostly dictated answers to questions rather than involving students in discussions to challenge their thinking. In some instances, when students failed to answer a question, teachers made comments such as “are you ready for the exam?” or “you make me feel sorry” (Fieldnotes, 18/8/97). In addition, some lessons we had planned did not take place in the way I had anticipated. For example, with TS4, we had planned a series of activities to be used when teaching “probability” in her Form 4 class.
Unfortunately, TS4 postponed these activities because she considered the topic less likely to be examined in detail, based on her evaluation of the structure of previous mathematics examinations (Fieldnotes, 10/8/97).

Because of these conditions, and since my data collection period was expiring, I decided to conclude the data collection process and proceed, as planned, with the administration of a final student questionnaire, the teacher interviews and the collection of data about students’ examination results.

5.3.1 The final student questionnaire

The aim of the final questionnaire was to obtain information about students’ feelings about the effectiveness of the research intervention. In particular, the aim was to determine the extent to which the intervention changed students’ attitudes to, beliefs about and knowledge of mathematics.

Having had the use of everyday experiences as a central focus in some of the planning and execution of mathematics lessons, I wanted to collect, through the final questionnaire, data regarding students’ feelings about the use of everyday experiences in their learning of mathematics.

5.3.1.1 Nature of the questionnaire

In order to allow for some degree of comparability between students’ responses to the first and final questionnaires, two items in the final questionnaire were similar to those used in the first questionnaire. The other three questions in the final questionnaire were intended to probe students about how they felt about learning mathematics, and what they liked or disliked about the approach of using everyday experiences.

A preliminary analysis of students’ responses to the first questionnaire indicated that some students (especially those at the DEC) did not understand some of the questions. For example, in response to the question “How would you like mathematics to be changed in order to make it more interesting for you?”, one student said “I like mathematics because it is easy” (D2QA066), while another said, “Because mathematics is very important” (D2QA060). This indicated that some students were responding to the “why”, rather than to the “how” issue as required by the question. In order to enhance clarity of the questions in the final questionnaire, all the questions were translated to Chichewa, a Malawian language commonly spoken and understood by most students. Both the English and translated versions of the questions were therefore presented in the questionnaire as shown in Appendix 8.
5.3.1.2 Administration of the questionnaire

The procedure for administering the questionnaires followed a similar pattern to that of the first questionnaire. After distributing the questionnaires to students, I requested them to respond to the questions in the best way possible, remaining anonymous if they wished to do so. However, the conditions under which the final student questionnaire was administered in the two schools yielded different response rates.

Having established a degree of rapport with students over the period of data collection, approaching the students to complete the final questionnaire did not present any problem. Consequently, I anticipated that I would get more questionnaire returns than at the beginning of the research. Unfortunately, I only received 81 completed questionnaires from Form 2 students at the DEC and 79 completed questionnaires from Form 4 students at the SEC. This was mainly due to reasons beyond my control. At the DEC, two weeks prior to administering the final questionnaire, a number of teachers had left the DEC because they were asked by the Ministry of Education to invigilate Form 4 examinations in other schools. For this reason, the Form 2 students had not been attending lessons in some subjects of their curriculum. In addition, their mathematics teacher, TD2, suddenly became ill. This resulted in students not attending any mathematics lessons during this time, and I was unable to take the lessons due to other engagements with teachers at the SEC. The students at the DEC seemed to have felt abandoned by their teachers and me. Hence their interest in the research activity seemed to have diminished due to the disrupted teaching program.

The Form 4 students at the SEC had already begun writing their national examinations at the time of administering the final questionnaire. Administering questionnaire before the start of the examinations was not possible because the students had not yet completed their mathematics syllabus. I had to wait until their teacher, TS4, was satisfied that the remaining topics had been covered.

During the time of questionnaire administration, organising Form 4 students in one place became difficult as most of them had already given up attending lessons. Instead, they tended to be scattered all over the school premises in an effort to secure a place for uninterrupted private study in readiness for the examinations. Nevertheless, I managed to get students' cooperation during an evening “prep” time, although it was clear that, not surprisingly, some of them found completing the research questionnaire a less pressing matter than the examinations at hand.
Finally, with respect to the Form 2 students at the SEC, the questionnaire return rate almost tripled from 54 for the first questionnaire to 152 for the final. Although the Form 2 students seemed to have demonstrated more willingness and interest in the research activities, some students tended to be overly possessive of their completed questionnaires, some students holding on to their questionnaires and only handing them in when I was about to leave the classroom. I felt at the time that this may have been an indication that they were not totally willing to communicate their written comments about the intervention.

5.3.2 Teacher interviews

I conducted individual interviews with TD2, TS2 and TS4 about their teaching background, perceptions of their mathematics teaching and the effects of the intervention on their classroom practices and students' learning. Although I knew the basic details about the teachers' teaching backgrounds, a discussion of these was necessary as it allowed me to collect some data about the relationship between teachers' backgrounds and their observed classroom practices.

An interview schedule (see Appendix 9) was given to the teachers two days prior to the interview. This was done in order to give teachers time to reflect on the research activities in terms of what they had personally gained from the research. This also allowed teachers to have considered opinions about the issues to be discussed in the interview, and to focus the interview on issues that they considered to be most important. Since the interviews were lengthy and needed to run uninterrupted for about an hour and half, special times during school hours were negotiated for this purpose. A full transcript of the tape recorded interviews was prepared and given to the teachers for alterations and comments.

5.3.3 Students' examination results

At the end of the 1997 academic year in Malawi, the Form 2 and Form 4 students involved in this study wrote national examinations in mathematics and other subjects. The Form 2 students wrote their examinations in October 1997 while the Form 4 students wrote theirs from mid-August to mid-September 1997.

The examinations are externally set and compulsory for all students at the two levels. The mathematics examination at Form 2 level consisted of 60 multiple-choice questions. The Form 4 examination was divided into two parts, one part consisting of 24 questions and the other had 12 questions. In the Form 4 mathematics examinations, students were required to provide detailed answers to these questions. Although externally set, the mathematics examinations at both Form 2 and Form 4 levels cover the topics provided in the syllabus.
One of the aims of the study was to determine the effects of the research intervention on students' knowledge of mathematics. The examination at the Form 2 level assesses material covered over a period of two years while the Form 4 examinations covered material taught over a four-year period. Due to its short time frame, the intervention in the two schools only covered a small proportion of the mathematics content in the syllabus. Consequently, I did not expect this intervention to produce major changes in students' performance in the national examinations. However, at the very least, the aim of the study was to establish that students' performance in the examinations had not deteriorated for reasons pertaining to students' participation in the research. Hence at the end of the study, examination results were collected from the group of students in this study in 1997 and the corresponding cohort in 1996. The aim was to compare the results from these two groups of students, and to establish that students' performance in the 1997 mathematics examinations had not diminished.

I collected examination results for the 1996 group while in Malawi. The processing of the 1997 examination results took place after I had returned to Australia. These results were mailed to me during 1998. Further correspondence with the teachers enabled me to collect their comments on students' examination results. Teachers were asked to comment on whether students had performed according to their (teachers') expectations, and whether the students in the two schools performed better or worse than students in other schools nationally.

As I was aware of the collaborative nature of this study, I kept the teachers informed of the progress I made in the analysis and interpretation of the research data at various stages after I had returned to Australia. Summaries of the analysis of examination results and other data as well as conclusions from the research were mailed to the teachers for comments.
CHAPTER 6
DATA ANALYSIS AND INTERPRETATION

Typical of most qualitative research, the data collection in this study produced an enormous quantity of data. With over 700 completed student questionnaires, students' mathematics examination results, over 50 hours of tape recording of meetings with teachers and education officials, nearly 200 pages of completed observation schedules, student lesson evaluations and fieldnotes, the task of analysing the data was overwhelming.

With such an extensive and overloaded pool of data, the process of analysing the data posed a great challenge. Although the analysis appeared to be a daunting exercise, my reading of the literature on data analysis techniques indicated that the exercise would not be as fearsome as I had expected. A description of data analysis as a process of "organising what you have seen, heard, and read so that you can make sense of what you have learned" (Glesne & Peshkin, 1992, p. 127), clarified that the analysis is essentially a process of meaning making. This provided the lenses through which I began the data analysis. While I had to answer the questions I had posed in the investigation, I also needed to manage the data in such a way that it provided me with a picture of the meanings that participants gave to mathematics and change in mathematics education in their experience.

Many qualitative researchers have emphasised that data analysis needs to be an ongoing process. Data analysis starts with the first data that the researcher collects and continues throughout the data collection period and during the process of writing up of the research itself. This study also experienced this multi-layered nature of qualitative data analysis. At several stages during the data collection, preliminary data analysis took place each time I reflected on my interactions with the research participants in the field. I kept a research journal in which I recorded my insights, hunches, speculations and reflections on a range of events during the data collection. My journal contained a distillation of issues from various data sources, particularly from classroom observations.

However, as researchers such as Woods (1986, p. 122) have commented, this in-the-field analysis remained at a speculative level since it contained reflections which were typically speculative and not very well formed. In addition, due to time limitations in the field, the analysis was not detailed and mainly reflected issues arising from my unfolding impressions of the events from the field at the time. Secondly, it did not address all the data, but mainly contained impressions
from my conversations with teachers, students and other informants. As Hughes (1994) notes, “immersion in the field leaves one almost too close to the data themselves to make any broader sense of them” (p. 40). The in-the-field analysis therefore needed to be reconceptualised.

The second stage of the analysis took place when I had collected all the data. In order to have a manageable analysis, I looked at the major data sources in detail. These were: the first and final student questionnaires, my fieldnotes (which mostly arose from my interaction with the teachers and students during the planning, teaching and reflection phases described in Chapter 5), notes of meetings and final interviews with teachers, and students' examination results and teachers' comments on these. However, in analysing these data I kept an open mind and attended to other (minor) sources of data, although they remained supplementary.

The approach I used in the analysis was to begin with the data itself. This was done in order to allow the analysis to be open to other insights that would emerge from the meaning-making process. However, following Tesch's (1990) notion of "organising system", I used questionnaire items and interview questions to structure the analysis of student questionnaires and final teacher interview transcripts, respectively.

This chapter begins with a description of the analysis of the first student questionnaire. This is done in order to provide background information about the students for whom this research intervention was planned. This analysis is organised in terms of establishing whether and why students found mathematics interesting or important to learn and what they perceived to be appropriate ways of making mathematics more interesting for them. In addition, the analysis describes the factors which students feel contribute to the difficulty of mathematics.

6.1 Setting the context: The first student questionnaire

To begin the analysis of the first student questionnaire, each completed questionnaire was given an identifying code that represented the school, year level, questionnaire type and the student number. For example, a questionnaire completed by a Form 2 student at the DEC was identified as D2QA001, with D2 denoting DEC Form 2, QA denoting first questionnaire, and 001 denoting the number of the questionnaire in random order. Similarly, a questionnaire completed by a Form 2 student at the SEC was identified as S2QA001, and one completed by a Form 4 student at the SEC was identified as S4QA001.
After putting identification codes on the completed questionnaires, key phrases and detailed comments from students’ responses to a question were entered in a computer file. An example of a computer-file entry is shown in Table 6.1 below.

Table 6.1: A Summary of a Student’s Responses to the First Questionnaire

<table>
<thead>
<tr>
<th>QUESTION ITEM</th>
<th>STUDENT’S RESPONSE (54QA001)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTION 1</td>
<td></td>
</tr>
<tr>
<td>A. Which of the following is closest to how you feel about mathematics?</td>
<td></td>
</tr>
<tr>
<td>(a) Very interesting (b) interesting (c) boring (d) very boring.</td>
<td>b the way numbers and letters are used in maths gives interest in the sense that things which seem impossible do exist in maths. Example: Taking a 1 from 0 to give -1.</td>
</tr>
<tr>
<td>B. Give reasons for your choice.</td>
<td></td>
</tr>
<tr>
<td>QUESTION 2</td>
<td></td>
</tr>
<tr>
<td>Do you think learning mathematics is important? Please, give reasons for your answer.</td>
<td>Indeed it’s of importance ... When there is an advertisement, maths is the first subject to be taken into account.</td>
</tr>
<tr>
<td>QUESTION 3</td>
<td></td>
</tr>
<tr>
<td>How would you like mathematics to be changed in order to make it more interesting for you?</td>
<td>Algebra and geometry have to be introduced in primary schools... The method of teaching has to be watched out. If a teacher is very cruel, then students do not comprehend the teaching.</td>
</tr>
<tr>
<td>QUESTION 4</td>
<td></td>
</tr>
<tr>
<td>What factors do you think contribute to the difficulty of mathematics? Please explain.</td>
<td>The laziness of students, not practising... Selfishness within teachers and students.</td>
</tr>
</tbody>
</table>

An example of a completed first student questionnaire is shown in Appendix 10. A detailed example of the computer-file entries consisting of other students’ responses to the first questionnaire is shown in Appendix 11.

Printouts of the data from the first student questionnaire were made. The data was then read question by question, beginning with responses to Question 1. This reading enabled me to gain familiarity with the data and, in the process, I was able to check that the entries represented an accurate transcription of the information from the original questionnaires.

As I read through the responses, I kept a sheet on which I recorded my comments to a particular response and the meaning I got from it (for an example, see Appendix 12). I also wrote comments on the questionnaire responses themselves (see Appendix 13). Some common themes emerged among responses. For
example, as a reason for finding mathematics interesting (Question 1B in the first student questionnaire), some students indicated that they were successful at mathematics. Such responses were coded "SU". Examples of such responses are shown below.

**SU:** I pass with good marks during examinations. (S2QA018)
**SU:** I can work out things easily. (S4QA112)

Other responses suggested that students felt partially successful or unsuccessful. These were coded "PS" (partially successful) and "IN" (interested but not successful), respectively. A range of other reasons for finding mathematics interesting emerged. These included reasons to do with the utility of mathematics (UM), the nature of mathematics (NM), and enjoyment when doing mathematics (EM). Examples of responses coded under each of these are shown below.

**PS:** I do well partly in Geometry and Algebra but in Arithmetic I need to work extra hard so that I should pass with flying colours and come out with an A. (S2QA051)
**IN:** I have a good time in a maths class and almost everything gets into my head properly, but I fail to apply the principles when I'm given a problem to solve. That's why it is not so very interesting to me. (S4QA073)
**UM:** Maths is very important to us because if you don't know maths you can't find a nice job. And again you will be very poor in this world. (D2QA116)
**NM:** The way numbers and letters are used in maths gives [me] interest in the sense that things which seem impossible do exist in maths. Example: taking a 1 from 0 to give -1. (S4QA001)
**EM:** When solving I feel like [I] am playing a game. (S4QA072)

Keywords in students' responses such as "thinking", "intelligence", and "brain" suggested that some found mathematics interesting because of its potential to "promote thinking". These were coded as "PT". Examples of students' responses in this category are as follows:

**PT:** Maths makes the brain to work efficiently, and a person who deals with maths grows scientifically. (D2QA190)
**PT:** Maths makes a student or person to think fast. It also makes one more intelligent. (S4QA126)
**PT:** Maths gives much time to test my brain whether it is capable of thinking or not. It is the only means that ensures that my brain is really functioning properly and efficiently. (S4QA051)

During the process of coding, decisions were made about categories to drop, combine or extend. For example, in answering Question 1B, some students gave responses which were associated with the quality of mathematics teaching. Such responses were initially coded "QT", that is, "Quality of Teaching". However, I extended the category QT in order to distinguish between students who found mathematics interesting because of "good teaching" and those who did not find
it interesting because of “poor teaching”. I therefore introduced the categories
“GT” for “Good Teaching” and “PT” for “Poor Teaching”.

Some responses were coded more than once. For example, as a reason for finding
mathematics interesting, one student said:

I feel like that because sometimes I am supposed to see how my brain
is working, but I didn’t mean it’s too interesting nor boring because it
has some bad effects. But I like to sit down and solve problems ... but
my problem is that I am not gaining anything and I always fail.
(SQA014)

In order to code this response, I employed a strategy that divided the response
into “units of data” each of which could “stand by itself” (Merriam, 1998,
p. 180). In the above response, the first unit of data: “I am supposed to see how
my brain is working”, was coded “PT”, that is, “Promotes Thinking”. The last
unit of data: “I am not gaining anything and I always fail” was coded “IN”, that
is, “Interested but Not successful”.

After categorising responses to a particular question, I calculated percentages of
the number of students whose responses were grouped in each category. For
example, in Question 1B of the first questionnaire, 5 out of 164 (that is, 3%) Form
2 DEC students said they found mathematics interesting or very interesting
because of “Good Teaching” (GT). Similarly, percentages of the number of Form 2
and Form 4 SEC students whose responses were grouped in the “Good Teaching”
(GT) category were calculated. The percentages of students in each category were
then compiled as shown in Table 6.2 below.

As shown in Table 6.2, the percentage totals do not add up to 100% because
some students did not respond to the question, while others gave more than one
response to it.

I then calculated the percentages of the number of students who gave responses
that were grouped in each category related to responses to Questions 2, 3 and 4
in the first student questionnaire. Appendix 14 shows the percentages of
students whose responses were grouped in each category for all the questions in
the questionnaire. These percentages were then entered in a Microsoft Excel file,
and graphs displaying the distribution of the categories were prepared for each
question. Information from these graphs facilitated the identification of patterns
in students’ responses to a particular question.

During the process of analysing the first student questionnaire, examples of
students’ responses that were representative of responses to a particular
question were highlighted. Some of these responses provided useful information
that enhanced a discussion of some critical issues about students’ views about
Table 6.2: Reasons Given for Finding Mathematics Interesting or Very Interesting (Question 18)

<table>
<thead>
<tr>
<th>Response Category</th>
<th>Form 2 DEC First: N=164</th>
<th></th>
<th>Form 2 SEC First: N=43</th>
<th></th>
<th>Form 4 SEC First: N=104</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Successful (SU)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Partially Successful (PS)</td>
<td>31</td>
<td>19</td>
<td>6</td>
<td>14</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Good Teaching (GT)</td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>14</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Gain Knowledge (GK)</td>
<td>8</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Utility of Mathematics (UM)</td>
<td>62</td>
<td>38</td>
<td>6</td>
<td>14</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>Promotes Thinking (PT)</td>
<td>16</td>
<td>10</td>
<td>10</td>
<td>23</td>
<td>31</td>
<td>30</td>
</tr>
<tr>
<td>Nature of Mathematics (NM)</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>7</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>Enjoy doing Maths (EM)</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Interested but Not successful (IN)</td>
<td>5</td>
<td>3</td>
<td>7</td>
<td>16</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

| Total                        | 136  | 84  | 42   | 97  | 113  | 110 |

Mathematics and change in mathematics teaching and learning. Such responses were coded as excerpts ("X") and identified in the computer files and printed copies of the questionnaire data (see, for example, Appendix 15). This coding system allowed easy access to and retrieval of these excerpts and facilitated the compilation of typical information about a particular response category, for example, as shown in Table 6.3 below.
Table 6.3: Examples of Excerpts Associated with Reasons for Finding Mathematics Interesting

<table>
<thead>
<tr>
<th>Response category</th>
<th>Excerpts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful (SU)</td>
<td>I pass with good marks during exams. (SQA018)</td>
</tr>
<tr>
<td>Partially Successful (PS)</td>
<td>I do well partly in Geometry and Algebra but in Arithmetic I need to work extra hard so that I should pass with flying colours and come out with an A. (SQA051)</td>
</tr>
<tr>
<td>Good Teaching (GT)</td>
<td>The teacher works hard, [and] is never absent. (SQA008) When the teacher is teaching, I feel more interested [because of] the way she teaches... (SQA059)</td>
</tr>
<tr>
<td>Gain Knowledge (RK)</td>
<td>I know more things from maths. (DQA054)</td>
</tr>
<tr>
<td>Utility of Mathematics (UM)</td>
<td>Without maths we cannot achieve a better life. (SQA060) If I learn more I will become an accountant. (SQA015)</td>
</tr>
<tr>
<td></td>
<td>According to the job I want to do, it's very much concerned with maths... But it only hurts me when I get poor results in maths but I like the subject. I find it very interesting when I practice it. [And] I can't drop maths. (SQA124)</td>
</tr>
<tr>
<td>Promotes Thinking (PT)</td>
<td>Maths makes me to think fast... It refreshes my brain, i.e. when I am studying other subjects I do done and after practicing it [maths] my brain is refreshed. (SQA030)</td>
</tr>
<tr>
<td></td>
<td>When you have a problem to solve and you don't know the means of doing it, it gives you the power of thinking deeply to overcome the problem. And you become a good thinker. (SQA095)</td>
</tr>
<tr>
<td>Nature of Mathematics (NM)</td>
<td>The way numbers and letters are used in maths gives interest in the sense that things which seem impossible do exist in maths. Example: taking a 1 from 0 to give -1. (SQA065)</td>
</tr>
<tr>
<td>Enjoy doing Mathematics (EM)</td>
<td>Mathematics is the only subject which shows that one knows what one is doing and as long as you do it you enjoy it. (SQA025)</td>
</tr>
<tr>
<td>Interested but Not successful (IN)</td>
<td>I enjoy it while I am learning but when it comes to exercise or exam I find my head emptied without any memory of what I learnt before. (SQA008)</td>
</tr>
</tbody>
</table>

6.1.1 Results from the first student questionnaire

This section describes students' responses to the first student questionnaire. Firstly, graphs displaying distributions of students' responses to the questions in the questionnaire are presented. This is done in order to present a profile of the main issues from the students' responses. Secondly, by referring to the distributions, patterns among the responses from the three groups of students (that is, Form 2 DEC, Form 2 and Form 4 SEC students) are identified. In addition, responses which illustrate the main issues from students' responses are provided.

By administering the first student questionnaire, I had intended to document preliminary information about the students involved in the study, that is, their views of, concerns about and justifications for learning mathematics. This information was used to determine whether there were any changes in students' learning after the research intervention.
Due to conditions in which the first student questionnaire was administered (see Section 5.1.5), the questionnaire return rates were not as expected. From a total of 329 Form 2 students at the DEC, only 195 returned the completed questionnaire. At the SEC, only 54 out of 189 Form 2 students and 126 out of 158 Form 4 students returned the completed questionnaires. Given these differences in questionnaire return rates, obtaining a general picture from the students, especially the Form 2 students at the SEC, was difficult.

6.1.1.1 Students' views of mathematics

Question 1 in the first student questionnaire was as follows:

A   Which of the following is closest to how you feel about mathematics:
   (a) very interesting  (b) interesting  (c) boring  (d) very boring

B   Give reasons for your choice.

Figure 6.1 below shows the distribution of students' responses to Question 1A. The percentages indicate the proportion of students who chose each of the options given in Question 1A. For example, there were 78 out of 195 (that is, 40%) Form 2 students at the DEC who said that mathematics was interesting.

According to Figure 6.1, the majority of students (that is, at least 80%) in each group found mathematics interesting or very interesting. However, the percentage of students who found mathematics very interesting is lowest in the Form 4 group.

The distribution of responses to Question 1A (see in Figure 6.1) suggests that there are essentially two categories of students in terms of how they viewed mathematics. One group consists of those who found mathematics interesting (that is, those who chose options (a) or (b) in Q1A) and the other consists of those who did not find mathematics interesting (that is, those who chose (c) or (d)).

The analysis of students' responses to Question 1B was therefore split into two parts, that is, to analyse the reasons why some students found mathematics interesting and why others did not.
6.1.1.2 Reasons for finding mathematics interesting

In their responses to Question 1B, students gave a variety of reasons for finding mathematics interesting. These reasons were grouped into nine categories as shown in Figure 6.2 below.
Figure 6.2: Reasons given for finding mathematics interesting (Q1B)
The construction of the horizontal axes of the graphs displayed in Figure 6.2 was carried out in such a way that categories that were related to each other were placed next to each other on the horizontal scale. For example, the categories “successful” and “partially successful” are related since they are both concerned with performance. The categories “nature of mathematics”, “enjoy doing maths” and “interested but not successful” are also related since they represent students’ intrinsic interest in mathematics. The other categories “Gain Knowledge”, “Utility of Mathematics” and “Promotes Thinking” are concerned with students’ perceptions about the values associated with learning mathematics. The horizontal scale shown in the graphs of Figure 6.2 (and in later figures) is therefore not linear but was constructed in such a way that related categories were placed next to each other.

Figure 6.2 shows that all three groups of students emphasised success and utility of mathematics as reasons for finding mathematics interesting. A greater proportion of Form 2 and Form 4 students at the SEC than those at the DEC found mathematics interesting because of good teaching and the ability of mathematics to promote thinking. According to Figure 6.2, a greater proportion of Form 4 students than others found mathematics interesting because of the nature of mathematics and enjoyment in doing it. For all three groups of students, there is little emphasis on gaining knowledge as a reason for finding mathematics interesting.

The reasons associated with success are mostly linked with students’ ability to pass examinations or follow what the teacher is saying during lessons. Although they pay attention in class, they still find it difficult to succeed in mathematics. This can be seen from the following comments:

I learn maths from the teacher on the chalkboard and [at] that time, I do understand what he is teaching. But the moment he rubs off I forget all those [things] he had taught. When he gives us an exercise to do I [find] it too tough. [For] this reason I feel it [is] boring.
(D2QA188)

[Maths] is very easy when the teacher is teaching, but very difficult to solve.
(S4QA065)

Acquisition of mathematical knowledge is seen by most students as a prerequisite for achieving a better life since it allows them to gain high status jobs, as illustrated in the following comment.

Maths is very important to us because if you don’t know maths you can’t find a nice job. And again you will be very poor in this world.
(D2QA116)

The usefulness of mathematics in enabling students to get a job seems to be an important factor which motivates students to keep learning mathematics. As
seen in the following comment, there is an indication that without the prospect of securing a job, students are more likely to drop mathematics.

According to the job I want to do, it's very much concerned with maths. The course I am going to do is very much concerned with maths. But it only hurts me when I get poor results in maths but I like the subject. I find it very interesting when I practice it. [And] I can't drop maths. (S4QA124)

As seen in Figure 6.2, a greater proportion of Form 4 students than the others gave descriptions that revealed their understanding about the nature of mathematics. They view mathematics as abstract knowledge, but nevertheless find it interesting and enjoyable to work with. The following comments illuminate this.

[In maths] we solve for diagrams which are not real and we feel triumphant after proving the theorem... (S4QA022)

The way numbers and letters are used in maths gives interest in the sense that things which seem impossible do exist in maths. Example: taking a 1 from 0 to give −1. (S4QA001)

Other comments such as the following indicate that some students regard mathematics as true and objective knowledge.

[Maths] is an interesting subject because always the answer is the same eg we can give the sum like 1 + 1 = 2. Anyone who finds that the answer is 3 is wrong. (S4QA066)

A comment from one student at the D&E suggests that it is the belief that "solving mathematics [problems] usually produces one true answer" (D2QA077) which makes the subject interesting and seemingly easier to work with than other subjects. However, some students, as can be seen below, do not find mathematics very interesting because of its objective nature.

I am interested but not very because this is a very difficult subject for one to get correct. It needs the whole Malawi to get the same answer... So it's difficult for me. (S4QA068)

6.1.1.3 Reasons for not finding mathematics interesting

As can be seen from Figure 6.1, very few students did not find mathematics interesting. Students gave four main reasons for this, namely, lack of success, poor teaching, the nature of mathematics and limited resources. The distribution of students' responses in these categories is shown in Figure 6.3 below.

All three groups of students emphasised lack of success as a reason for not finding mathematics interesting. The Form 2 students in both schools emphasised
Figure 6.3: Reasons given for not finding mathematics interesting (Q1B)
poor teaching as a reason for their lack of interest in mathematics, while the Form 4 students placed less emphasis on poor teaching and more on the objective nature of mathematics. One of the Form 4 students commented as follows:

Maths problems need only one answer throughout the nation or internationally. So it is always difficult to solve and find out the real answer. (S4QA041)

Their descriptions of lack of success in mathematics indicate that students mostly blame themselves for not doing well in mathematics. This can be seen in the following comments:

- We don’t have wisdom of thinking much. We forget everything we have [been] told by our teacher. For us to get everything told by the teacher, [it] is very difficult ... (D2QA108)
- Maths is boring to my side but I think our teacher is trying her best. But ... I don’t know what actually happens to me. (S2QA040)

Some students stated that mathematics can only be accessed by a limited number of students and stressed that “only a small number of people who can do better in maths” (S4QA039).

The Form 2 students at the DEC are the only group which gave limited resources as a reason for not finding mathematics interesting. They placed more emphasis on the shortage of mathematics teachers than on lack of other resources such as textbooks.

6.1.1.4 The importance of learning mathematics

Question 2 in the first student questionnaire was as follows:

Do you think learning mathematics is important? Please, give reasons for your answer.

An analysis of students’ responses to this question identified eight categories of reasons students gave for the importance of learning mathematics. The distribution of these categories is provided in Figure 6.4 below.

As displayed in Figure 6.4, related categories were placed next to each other on the horizontal scale. For example, the categories “Promotes Thinking” and “Gain Knowledge” specifically refer to mathematical knowledge — that is, learning mathematics enables students to gain mathematical knowledge and become better (mathematical) thinkers. The categories “Use in Other Subjects” and “Further Education” are related since they are concerned with the use of mathematics in general education. The other categories, “Job Opportunities”, “Business Use” and “Use at Work” are all directly concerned with utility aspects of mathematics.
Figure 6.4 shows that most of the students in the three groups find it very important to learn mathematics. All three groups of students place most emphasis on the utility aspects of mathematics, particularly on the importance of mathematics in enabling students to secure jobs and engage in various work-related activities in everyday life. There is also some emphasis placed on mathematics promoting thinking. Students believe that mathematics “increases their thinking capacity” and “polishes their brains”.

Very few students view mathematics as a useful tool for learning other subjects, and even fewer students do not see it as important for further education. Students’ comments such as the following suggest that some students view mathematics as important mostly because it is related to their career aspirations.

According to my vision, learning maths is important because this is [the] only subject which is very close to what I want to be doing after my school. (S2QA040)

I don’t think learning maths is important because the career which I envy most has nothing to do with maths. (S4QA063)

In general, students’ responses to Question 2 show that most of them emphasised the utility of mathematics as the reason why they found it important to learn mathematics. Very few of them see mathematics as important for use in other subjects or further education.

6.1.1.5 Ways of changing mathematics to make it more interesting

In the first questionnaire, students were asked the following question (Question 3):

How would you like mathematics to be changed in order to make it more interesting for you?

Students’ responses to this question reveal that students consider mathematics both as content and process. Their responses were grouped into fourteen categories. These are displayed in Figure 6.5 after the next page.

Viewed more broadly, the categories were seen as belonging to five broad groups. Four of these were categories concerned with change in:

- teaching styles (ie, Change Teaching, Adequate Teacher Training, and More Group Work);
- mathematics content and assessment (ie, Change Content, Change Language, Choose Branch, Change Assessment, and Frequent Testing);
Figure 6.4: Reasons given for the importance of learning mathematics (Q2)
Figure 6.5: Ways of changing mathematics to make it more interesting (Q3)
• learning style (i.e., Regular Practice);

• resources (i.e., More Teachers, Increase Learning Time, and More Learning Resources)

The fifth group consisted of responses which suggested that students did not want mathematics to be changed or wanted it to be changed but did not suggest how. The construction of the horizontal scale in the graphs of Figure 6.5 was based on this broad grouping of categories.

As Figure 6.5 shows, all three groups of students emphasised that teaching styles need to be changed in order to make mathematics more interesting. Comments from the Form 2 students at the DEC reveal that, in general, they wanted the teacher to put more effort into teaching.

Lazy teachers are not allowed [in] mathematics. (D2QA079)
I would like teachers to teach more than before. (D2QA138)
Teachers must work hard. (D2QA140)

Secondly, students emphasised the need for change in the mathematics content, particularly because they saw mathematics as containing “many tricks” (D2QA080), and because some of its parts such as Geometry and Algebra were seen as “useless” (S2QA040). Students also wanted the mathematics content to be simplified, for example, by changing the language used in teaching it, or allowing students to choose branches of mathematics in which they were more capable of succeeding.

Figure 6.5 suggests that the Form 2 and Form 4 students at the SEC wanted to have more practice in writing tests than is the case with Form 2 students at the DEC. It seems that the Form 2 students at the DEC wanted to have more time to learn and were less concerned with practice in writing tests, although a few of them found the use of multiple-choice examinations inappropriate in their current assessment.

The Form 4 students at the SEC particularly emphasised that they wanted to be given exercises which were similar to examples they did in class. This can be seen in the following remarks:

The exercise should be the same as examples. Let’s say in the example there was nothing dealing with $\frac{1}{2}, \frac{3}{4}, \frac{1}{4}, \frac{1}{5}$, and in the exercise there is such a question, this confuses a lot. It may be simple but because they did not give us such an example, that’s why we fail. (S4QA074)

Examples given are simple but exams are difficult. Change this system. (S4QA006)
These remarks suggest that some students resist being given mathematics problems which are different from the examples done in class.

All three groups of students emphasised the need to have more learning resources, particularly textbooks. This need is associated with students’ wish to have more opportunities for practising mathematics on their own at home.

The thing you can help us [with] is to provide us with books so that sometimes we can solve mathematics [problems] ourselves. (D2QA015)

[Maths] can be [made] more interesting by providing us with special books, eg I myself I haven’t got secondary maths [book 2] ... so that it becomes very difficult [for] me to study [on] my own. [This means] that I depend only [on] my teacher. (S2QA005)

I wish those publishers of books should publish more model-answer books [from] which students may work out a problem [and] then check it [with] the given answer ... This ... can encourage students in maths who study on their own at home. (S4QA027)

A small proportion of students in both schools do not want mathematics to be changed in any way. While there are various reasons given for this, some students suggest that it is they themselves who need to change. Students, particularly those at the SEC, seem to blame themselves for not succeeding in mathematics, either because of their poor background in mathematics or lack of practice in solving mathematics problems.

Mathematics should be the same as it is, because it is not boring because of the subject itself, but a personal problem in connection with my background. (S4QA034)

There is no way maths can be changed apart from how it is now, but what we are lacking is practises and understanding the questions. The only way of making it more interesting [for] somebody is doing practices... (S4QA086)

Some students stress that there is no need to change the “orders” of mathematics. They argue that changing mathematics would lead to a deterioration of the standard of education.

Maths cannot be changed because once changed education cannot grow up. (D2QA114)

It is not good to change [maths] because if we change it to be simple it is bad. [For example] the Ministry of Education changed books of lower classes like Standard 4 English to be simple. So ... [when students] reach Form 4 [they] fail to speak English. (D2QA168)

Maths is not supposed to be changed but [there is need to] find ways of improving it so that it will be an interesting subject. The changes of maths especially in primary is causing a great trouble to those who pass and start secondary. So no changes should take place in maths. (S2QA030)

In summary, as shown in Figure 6.5, the responses suggest an emphasis on changing teaching styles and the mathematics content in order to make
mathematics more interesting. The Form 2 and Form 4 students at the SEC emphasise the need to practise mathematics problems more and want to be given frequent tests, while the students at the DEC want more learning time.

6.1.1.6 Factors contributing to the difficulty of mathematics

Question 4 in the first questionnaire was as follows:

*What factors do you think contribute to the difficulty of mathematics? Please explain.*

Due to the similarity of this question and Question 3 discussed above, the analysis of students' responses to Question 4 was similar to that used in Question 3. In Question 3, which asked students to suggest ways of changing mathematics in order to make it more interesting for them, students wanted changes in teaching and assessment styles, more practice in solving mathematics problems and an increase in learning resources.

Figure 6.6 below shows the distribution of students' responses to Question 4. As can be seen in Figure 6.6, students again emphasised teaching and assessment styles, insufficient practice and learning resources as the main factors contributing to the difficulty of mathematics. In addition, students' responses, especially those from Form 2 students in both schools, suggest that lack of teaching effort also contributes to the difficulty of mathematics. Typical comments in this category of responses highlight "laziness" and "lack of dedication" (D2QA023) among mathematics teachers. Some students also believe that mathematics is inherently difficult since "maths (problems) have only one answer" (D2QA077).

6.1.2 Emerging issues

In this section, I describe three major issues emerging from the analysis of the first student questionnaire.

6.1.2.1 Focus on success

The analysis of the first student questionnaire suggests that success is a crucial aspect of students' learning in mathematics. Success was a major aspect of the reasons why students found mathematics interesting. Students want to be successful at mathematics in order for them to find it interesting. Given this emphasis on success, one gets the picture that these students consider mathematics mainly as a performance subject — that is, something which has to be done, learned and passed. As suggested by their responses to Questions 3 and 4 in the first questionnaire (see Figures 6.5 and 6.6), practice in solving mathematics problems, writing frequent mathematics tests and teachers putting
more effort into teaching are seen as vital means through which students can achieve success in mathematics.

Figure 6.6: Factors contributing to the difficulty of mathematics (Q4)
6.1.2.2 Focus on utility

All three groups of students found mathematics interesting particularly because they found mathematics useful. By learning mathematics, students hope that it will be of some use to them in their everyday lives in the future. This result is strongly supported by students’ responses to Question 2 as can be seen in Figure 6.4. As the following remark suggests, students learn mathematics because of its critical utility for all. It is important for survival and competitive participation in society:

Maths is very important to us because if you don’t know maths you can’t find a nice job. And again you will be very poor in this world. (D2QA116)

6.1.2.3 Limited resources

The analysis of the first questionnaire suggests that the Form 2 students at the DEC consider the availability of learning resources as an important factor in their learning of mathematics more than the other students (see Figures 6.3, 6.5, and 6.6). They wanted more mathematics teachers, textbooks and an increase in learning time. Although not explicitly stated in students’ responses, it can be deduced that the need for more learning resources is related to success in mathematics. For these students, the availability of learning resources is an important prerequisite for any learning to take place.

Overall, the analysis of the first student questionnaire gives a picture of a group of students which has very extrinsic motivations for engaging in mathematics. They want to succeed at it and use it in their everyday lives. They are interested in mathematics not particularly because of what the subject is about, but rather because of what the subject can do for them, its value in everyday life. In general, these students seem to value a mathematics education which enables them to succeed in the subject and inculcates practical skills needed for participation in activities outside school.
6.2 Using everyday experiences in the classroom: Observation schedules, lesson evaluations, and the research journal

I used observation schedules to record the following aspects of mathematics lessons: date, time, year level, number of students, teacher’s name, the physical setting, topics and an outline of the lesson, and examples of everyday experiences used in the lesson. In addition, the observation schedule contained information about the types of activities and a record of episodes, comments on lesson activities and further thoughts that occurred during the observation process. Appendix 16 shows examples of completed observation schedules. The first three observation schedules were completed by TS4, TS2 and TD2, respectively, when they were observing my lessons and the last three were completed by me when I was observing TS4, TS2 and TD2, respectively. In all, I had 70 completed observation schedules to analyse.

As described in Section 5.2.3, the conditions under which the observation process took place resulted in insufficient classroom observation data being collected. Most of the observation data lacked detailed and systematic descriptions of events and lesson activities. However, I completed a research journal on a regular basis in order to record insights, reflections and reactions to events during teaching activities in the classroom. In addition, on several occasions during the data collection process in the classroom, I asked students to complete open-ended lesson evaluations in which they were asked to comment on how they felt about the lessons, how they benefited from teaching activities, and, generally, what they felt was important about the use of everyday experiences in teaching mathematics. Therefore, the description of the teaching activities, how teachers and students felt about the activities, and the context in which everyday experiences were used, is based on an analysis of the data from observation schedules, student lesson evaluations and the research journal.

This section begins with the analysis of the observation schedules completed by teachers and me. The aim of this analysis is to find out some of the aspects of the lessons which teachers valued most in teaching mathematics. In addition, by analysing the data from my observation schedules, the analysis describes lesson aspects which I felt teachers valued most during teaching sessions.

The section then discusses two types of lessons: one in which no everyday experiences were used and the other in which everyday experiences were used. I discuss a lesson in which no everyday experiences were used despite having planned to use them in order to enable students to learn more about mathematics
and its connection to their society. A lesson in which everyday experiences were used is then discussed, examining it in terms of the role of everyday experiences in teaching mathematics, from the students' and the teacher's perspectives. The aim is to find out what the students and the teacher valued most in the lesson, and to use the analysis of this lesson in order to discuss the constraints and potentials that the use of everyday experiences had for student learning. A detailed analysis of students' evaluations of other lessons is not presented here because these evaluations were more general and involved students describing their recollections of various lessons rather than focusing on a particular one. However, data from other lessons will be used to supplement the analysis and discussion of issues from other data sources.

An analysis of the research journal is also carried out. This is done in order to provide a profile of issues emerging from reflections on various data sources including those from classroom observations.

To conclude the section, I describe the major themes emerging from an analysis of observation schedules, lesson evaluations and the research journal.

6.2.1 Classroom observation schedules

In analysing the observation schedules, I began with the comments which teachers made when they observed my lessons. This was important for two reasons. Firstly, I wanted to get teachers' perspectives on classroom events — that is, to get some insights about the aspects of mathematics teaching they valued most, and their preferred ways of working in the classroom. Secondly, I anticipated that the analysis of the teachers' data would generate insights that could serve as starting points for analysing the rest of the observation data.

Altogether, the teachers completed ten observation schedules. TS4 completed five observation schedules; TS2 completed four while TD2 completed only one observation schedule. I analyse TS4's comments in detail below because she made more detailed observations than the other teachers.

Figure 6.7 below shows an extract of observation notes made by TS4 when observing Lesson 8 on Geometrical Constructions. This extract is part of a lesson in Appendix 16.
<table>
<thead>
<tr>
<th>Activities</th>
<th>Comments</th>
<th>Activity types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heading of the lesson.</td>
<td>Well written on the board (good use of the blackboard).</td>
<td>Writing.</td>
</tr>
<tr>
<td>Question written on the board.</td>
<td>Well written on the board and clearly seen at the back of the classroom.</td>
<td>Writing.</td>
</tr>
<tr>
<td>Sketching the information in the question by means of a diagram.</td>
<td>Explanation of the sketch quite good.</td>
<td>Explanation.</td>
</tr>
<tr>
<td>Labelling of the sketch.</td>
<td>Well labelled.</td>
<td></td>
</tr>
<tr>
<td>Construction.</td>
<td>Pupils were doing the construction on their own. Some pupils were not using rulers and compasses, they were using free hand.</td>
<td>Group discussion (some).</td>
</tr>
</tbody>
</table>

*Figure 6.7: TS4's comments to Lesson 8 (27/5/97): Geometrical Constructions*

As can be seen in Figure 6.7, TS4's comments about the lesson were mostly about presentation of blackboard work — that is, whether the writing was clear and could be seen from the back of the classroom. Her comment about students using free hand rather than rulers and compasses indicates the significance TS4 attaches to "good presentation" of class work. She wants to make sure that diagrams are drawn accurately by using mathematical instruments rather than free hand.

TS4's comments on other lessons were fairly similar to those displayed in Figure 6.7. For example, in her comments on Lesson 10 (on the same topic as above), TS4 noted that the constructions were "well presented" (TS4, Lesson Observation 10, 29/5/97). Again here, TS4 is keen to see that classroom work is presentable.

In the same lesson (Lesson 10), TS4 noted that "Not much was done, [the calculations were] left to be completed by the students". This comment suggests that TS4 was particularly concerned if the teacher gave a lot of work to students. She wanted the teacher to do most of the work and leave "just enough" for the students. In Lesson 14, her comments also suggest that TS4 wanted students to be taught so that they are not left in suspense. TS4 commented: "The example was not fully explained. Maybe it left pupils in suspense" (TS4, Lesson Observation 14, 4/6/97).

In Lesson 11, TS4 noted that "some of the group members were just making noise irrelevant to the lesson" (TS4, Lesson Observation 11, 2/6/97). This remark suggests that, according to TS4, comments from students needed to be seen to be relevant to the lesson activity in progress. This may also suggest the possibility of
her wanting the teacher to be seen to be in control of the learning situation, to make sure that every student concentrated on the given tasks, in silence.

The analysis of TS4’s comments indicates some clear imperatives about the roles of the teacher and students in the classroom. For TS4, the teacher needs to present class work accurately. Classroom examples needed full explanations, without leaving students in suspense. The role of students is to listen and follow the teacher’s explanations.

The above analysis for the observation data from TS4 suggested that “teacher’s role” and “students’ role” were key issues that needed to be followed up in the analysis of observation data for the other teachers. However, this process was rather limiting since it was likely that some issues could emerge from one teacher’s observation data but not from that of the others. Therefore, as a next step in the analysis of the observation data, I read through the rest of the observation schedules, that is, those completed by TD2, TS2 and me. I then revisited my analysis of TS4’s schedules.

In the analysis of the rest of the observation schedules, I first noted the topics of each lesson and whether there were any everyday experiences used in the lesson. I then read through each the observation schedules again and highlighted key words and phrases that represented critical episodes in the lessons. For example, in observing a lesson on Area of Triangles and Parallelograms in which I was teaching, TD2 noted that:

the introduction to the topic [was] meaningful, lively and relevant, [and involved] “direct use of everyday examples which students were familiar with”. (Lesson Observation 45, 11/8/97)

The above comment meant that TD2 valued the use of everyday examples. Hence as a key aspect in the analysis, I looked for key sentences and phrases that indicated whether teachers valued the use of everyday experiences. In addition, there were comments which showed that time pressure prevented teachers from fully appreciating the use of everyday experiences in teaching. For example, while TD2 recognised the relevance of the use of everyday experiences, he noted, among the aspects that I (the researcher) needed to consider, the need to be “fast [in teaching] in order to catch up with time” (Lesson Observation 45, 11/8/97). Therefore, time and the value of everyday experience were key aspects that I looked for in the observation data.

Other key words and phrases which represented critical episodes in the lessons were noted. At this stage, I began to code them in order to denote the themes embedded in these episodes. For example, the key phrases “little opportunity to ask questions”, “students listening”, “students just sitting”, indicated the teacher
and student roles in the classroom. Other key words such as “Do not be quiet, the exam timetable is out” indicated the role of assessment in teaching. Other themes emerged such as the role of reflection and the role of content. Appendices 17a, 17b and 17c show a summary of the analysis of the observation schedules. These Appendices show the lesson episodes and issues associated with them. In these Appendices, italicised comments indicate that the teacher in question was the observer, while non-italicised comments indicate that the teacher was being observed. Issues arising from the Appendices will be described in detail in later sections.

To complete the analysis of the observation schedules, I created a table indicating how many lessons involved the use of everyday experiences and the teacher’s class in which this happened. I also noted whether the type of topic was either Algebra, Arithmetic or Geometry. Table 6.4 below, developed from Appendices 17a, 17b, and 17c, shows the number of lessons in which everyday experiences were used in each of the three teachers’ classes.

Table 6.4:
The Extent to Which Everyday Experiences Were Used

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Number of observations</th>
<th>No. of lessons in which everyday experiences were used</th>
<th>No. of lessons in which everyday experiences were not used</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD2</td>
<td>17</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>TS2</td>
<td>32</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>TS4</td>
<td>21</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>20</td>
<td>50</td>
</tr>
</tbody>
</table>

It needs to be noted here that, although Table 6.4 shows that there were more lessons in TS4’s classes in which everyday experiences were used, some of these lessons were repeated. This is because TS4 had three sets of Form 4s. Out of the 10 lessons, there were 2 lessons on Variations, 3 on Bearings and Distances, and 2 on Probability. Therefore, ideally, there were 6 different lessons in which everyday experiences were used in TS4’s classes. In addition, 3 of these were taught by me and TS4 taught the others. Similarly, there were 4 (instead of 6) different lessons which used everyday experiences in TS2’s classes. However, all the 4 lessons in TD2’s classes were different. Although TD2 had two sets of Form 2s, they were combined during mathematics lessons.
It needs to be mentioned again that although the 20 lessons (see Table 6.4) used everyday experiences, the use of everyday experiences played a rather more limited role than I had intended. However, as will be shown in a later section, there were some exceptions to this.

The number of lessons in which everyday experiences were used also depended on the nature of the topic. Table 6.5 below, developed from Appendices 17a, 17c and 17e, shows the number of lessons according to the type of topic, that is, Algebra, Arithmetic and Geometry.

Table 6.5
The Extent to Which Everyday Experiences Were Used in Various Topics

<table>
<thead>
<tr>
<th>Topic Type</th>
<th>Algebra</th>
<th>Arithmetic</th>
<th>Geometry</th>
<th>Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>TD2</td>
<td>TS2</td>
<td>TS4</td>
<td>TD2</td>
</tr>
<tr>
<td>No. of lessons with use of everyday experiences</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>No. of lessons without use of everyday experiences</td>
<td>3</td>
<td>16</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 6.5 shows that there were relatively more lessons in Algebra than in Arithmetic and Geometry which did not involve the use of everyday experiences, particularly in the case of TS2. There were 4 lessons which involved Solving Inequalities, 4 involving Formulae and Substitutions, 5 which involved Linear and Simultaneous Equations and 2 which involved Factorisation of Algebraic Expressions. Although I observed more lessons in TS2’s classes than in the others due to timetable clashes, on balance, as can be seen from Table 6.5, Arithmetic topics had more potential to involve the use of everyday experiences than Algebra and Geometry topics.

6.2.2 A study of one lesson in which no everyday experiences were used

In this section, I describe a lesson in which everyday experiences were not used in spite of the teacher and I having planned to do so. The aim here is to describe the lesson, showing its potential to facilitate students’ understanding of mathematics.
and its relationship to everyday life events. I describe a lesson in TS4’s class as an example.

TS4 taught a lesson on Probability in Form 4. The lesson was intended to describe everyday situations which could enable students to build their understanding and application of the concept of probability, and to enable them to estimate probabilities of everyday events.

In order to meet these aims, we made two discussion plans with TS4. The first involved a discussion of the “Top of the Class Oral Quiz Competition” in which her school had participated. The plan was as follows:

- In order to introduce the concept of probability, we could try to get students to give examples of everyday situations in which people talk about “chance”, that is, the chance of something happening. As an example, we could let students recall a time when their school had a “Top of the Class Oral Quiz Competition” with another school. [The competition involves eight “best” students, four from each school]. Students would recall that the Quizmaster always says: “Which team would like to start? Heads or tails?” In order to decide which team starts, the Quizmaster tosses a coin.

- Students will probably say that sometimes the team which chooses “Heads” does not start first. A discussion of this situation could lead us them to understand some of the probability terms such as “bias”. We could ask them to comment on the “fairness” of using the coin-tossing strategy for determining which team starts during the Top of the Class Oral Quiz Competition.

- Students would be asked to describe other games they play and the types of strategies they use to decide who starts to play. A series of coin-tossing experiments could then follow.

- As another activity, we could ask students the following question: “Recall a situation when one of your female relatives had been expectant. Did you think they were going to have a baby boy or baby girl? What finally happened? What can you say about the chance that the baby born will be a girl, for example?”

- Here, we may expect students to say that the chance is 1/2.

- As an extension, we could collect information from students about the total number of sisters and brothers born in their family. From this information, we could find out whether there are more girls being born than boys. We could then compare this information with the data from the National Statistics Office of Malawi (National Statistical Office, 1996) which shows that there are more females than males are born in Malawi. We could then discuss why this is the case, and whether it is the same in other countries. (Notes of Meeting 15, TS2 & TS4, 7/8/97)

This lesson had the potential to make the introduction of the topic more meaningful to students since it was intended to refer to events which students had observed (Top of the Class Competition). The lesson had the potential to let students know each other’s family histories (second activity), and more specifically, to draw students’ attention to what Chimwenje (1997b) calls
"emerging" and "contemporary" issues in the Malawian society which need to be discussed and understood by the youth in schools in order to "broaden the learner horizon" (p. 96).

In the second activity, we had planned to show students some raw data about birth rates from different parts of Malawi. For example, according to the National Statistical Office (1996, p. 12), proportionally, more children are born in rural than urban areas. Although not specifically about mathematics, this extension would allow students to know more about issues affecting their lives.

Unfortunately, this discussion did not take place. Instead, TS4 focused on a list of questions which were intended to serve as exercises based on the above discussion and an activity on "playing cards". Although students were familiar with the context of playing cards, very little discussion involved connecting the context and the solution to problems on the list. TS4 paid more attention to the individual questions such as "What is the probability of drawing an A from the standard pack of cards? Answer please" (Lesson Observation 63, 25/8/97). Although there were several opportunities in the lesson when TS4 could have used the context in order to discuss the differences in students' suggestions (for example, some said the probability was $\frac{1}{4}$, $\frac{1}{13}$ or $\frac{1}{52}$), TS4 mostly referred students to the question. She frequently repeated the question rather than extend on productive suggestions from students.

TS4 focused more on solving the problems rather than discussing the context in which these could arise. In this case, content was more important than process.

6.2.3 A study of one lesson based on the use of everyday experiences

As described in Section 5.2.2, TS2 and I taught a lesson in Form 2 which concerned the topic Average. The lesson was based on a multiple-choice question described in Figure 5.1. The question is repeated below for convenience.

According to the Mingale Secondary School Football Association, during the match between Mingale and Malapa schools, the average number of "free kicks" awarded was 10. The possible number of "free kicks" awarded for each school was:

(a) Mingale: 7; Malapa: 13
(b) Mingale: 8; Malapa: 12
(c) Mingale: 9; Malapa: 11
(d) Mingale: 10; Malapa: 10

Which of the above is correct? Why?

There were two aims for teaching this lesson. Firstly, it was planned as a response to students' request to be given an opportunity to practise solving
mathematics problems involving multiple choice items. The students made this request because they wanted to practise solving mathematics problems of the multiple-choice type which are used in their national examinations. Secondly, the aim was to use a problem which had the potential to engage students' reasoning in mathematics. By using the context of a football game which had taken place at their school, we anticipated that this would facilitate students in connecting mathematics with everyday experience. We anticipated that the context embedded in the problem would stimulate dialogue and reflection among students. In addition, we hoped that it would also facilitate students' solutions to the problem.

A description of how the lesson proceeded is presented in Section 5.2.2. Briefly stated, the question generated some vigorous discussion and debate. The discussion took place between two groups of students, one which believed that option (d) was the best answer, and the other which said that all options were correct. At the conclusion of the lesson, most of the students were "convinced" that all the options were correct.

At the end of the lesson, students were asked to describe in writing how they felt about the lesson. From a total of about 120 students (from three classes) who were present in that lesson, only 56 of them handed in their comments. The comments were brief. They ranged from one line to about half of an A4-page.

6.2.3.1 Analysis of students' comments on the lesson

To begin the analysis, all the evaluation forms containing the comments were given identification numbers. For example, one of the evaluation forms was coded "S2LEA001", where "S2" stood for a student in Form 2, "LEA" for Lesson Evaluation A, and "001" for the student number.

I analysed students' comments on the Average lesson in a similar way as I had done with students' responses to the first questionnaire. I read all the comments and made notes on them. I highlighted key comments, and performed some coding and categorisation in order to get a sense of what the comments were about. The main aim of the analysis was to enable me to get some insights about what students liked or disliked about the lesson, and, more generally, what students felt to be significant aspects of the lesson. For example, the following comment from a student indicates that they believed the lesson enabled them to gain a deeper understanding of the concept of average.

I can differentiate [between] a mean and a median. I have also realised that not only equal numbers are used to find the average or the sum of the two teams' free kicks. (S2LEA001)
A key aspect in the above comment is that this student realised that the term "average" did not necessarily mean that the numbers to be averaged needed to have the same value.

There was a group of students who felt that they had understood the concept of average so well that they would never fail a question concerning averages in the examination. The following remarks illustrate this.

I want to inform you that I understood [the lesson] about averages well, and [I] am sure that I will never fail when I meet a question about averages. (S2LEA018)

To say the fact, I have understand this lesson very well. And, if I am going to fail it on [the] examination, then it will be my problem. (S2LEA020)

For such students, an important aspect of the lesson was that it enabled them to understand the concept and gain confidence to enable them to succeed in the examination. For these students, success in the examination was very important. At this point, the analysis showed that understanding and success in mathematics were two aspects which students found important about the lesson. An analysis of other students' comments enabled me to develop further categories. For example, several students commented that they liked the lesson because it enabled everyone to "debate" and "oppose" each other's answers to the question. However, some students disliked the long debate since they felt the discussion was a waste of time because it was clear what the answer to the question was. Hence key categories here were "liked dialogue" and "disliked dialogue". Other comments indicated that students enjoyed learning or liked the fact that their teacher and I were teaching together. However, a number of students stated that they did not understand anything about the lesson nor follow what went on in the lesson. A list of key comments on the lesson and their categories is provided in Appendix 18.

Students' comments on the lesson fell into nine categories. Table 6.6 below shows the distribution of these categories.
Table 6.6
Distribution of Categories of Students' Comments on the Average Lesson

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference to everyday experiences</td>
<td>1</td>
</tr>
<tr>
<td>Enjoyed Learning</td>
<td>24</td>
</tr>
<tr>
<td>Felt Successful</td>
<td>20</td>
</tr>
<tr>
<td>Understood Better</td>
<td>18</td>
</tr>
<tr>
<td>Liked Dialogue</td>
<td>7</td>
</tr>
<tr>
<td>Promoted Thinking</td>
<td>5</td>
</tr>
<tr>
<td>Liked Collaboration</td>
<td>2</td>
</tr>
<tr>
<td>Did Not Understand</td>
<td>11</td>
</tr>
<tr>
<td>Disliked Dialogue</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>90</strong></td>
</tr>
</tbody>
</table>

The number of responses add up to more than 56 because some students' comments were coded more than once.

6.2.3.2 Key issues from the analysis: Students' perspective

According to Table 6.6, 43% (i.e. 24 out of 56) students commented that they greatly enjoyed the lesson on Average. However, most of the students reacted to this lesson in a way that I had not expected. As described below, students seem to have focused more on aspects of the lesson which were particularly important for them. There was little mention in their comments about the context in which the problem was set and the role of everyday experience in the lesson.

Link to the use of everyday experiences

Out of a total of 56 students who made comments on the lesson, there was only one student who stated that they had enjoyed the lesson because it involved the use of a context which was familiar to them — that is, things they see in their everyday life. The comment was as follows:

Today's lesson was really nice to say the reality. This is because the examples which were given were the ones which happen obviously. (S2LEA001)

There is an indication that this student recognised the strength of the lesson as having been based on "examples" which they see in their everyday lives, and, in the context of this lesson, the fact that this lesson was based on a football match which they had watched on the weekend. Because of the lack of specific
reference to the context of the question, it is quite likely that, for many other students, the football context was either unimportant or played a marginal role in the lesson.

**Understanding**

Rather than facilitate students' recognition of the connections between mathematics and everyday reality, the football context seems to have assisted students gain more understanding of the mathematical content. This can be seen from the 32% (i.e., 18 out of 56) students who commented that they had understood the lesson better than other lessons based on the same topic, Average.

A typical comment in this category was the following:

I have learnt quite a lot [on] how to find the total number of free kicks when given the mean (average) free kicks and the number of teams... . I have realised that not only equal numbers are used to find the average or the sum of the two teams' free kicks. On this I mean that at first I only knew that \( \frac{10 + 10}{2} \) will give us the correct average while, \( \frac{13 + 7}{2} \) is not true because the two numbers are different in value. (S2LEA001)

The above remarks indicate that the student gained more understanding about the content. He understood more about the meaning of the term average and the steps involved in calculating averages. This student, and most of the others who made comments on this lesson, made very little reference to the context of the problem. They were mainly interested in understanding the content. They did not think beyond the content, to relate to issues concerned with the everyday context in which the problem was set.

While it is possible that the football context made some students understand the content better, it is also quite likely that the context did not enable others to understand the question. This is particularly the case for the 20% (i.e., 11 out of 56) students who did not understand the question since they did not see the possibility that the number of free kicks could be 7 and 13. For these students, their understanding of average was that the numbers to be averaged needed to have the same, that is, 10 free kicks for each of the two teams as referred to in the question.

**Focus on Success**

Students made frequent comments about "failing", "passing", "forgetting" and "examinations". Such comments were made by 36% (i.e., 20 out of 56) students (see Table 6.6). A key aspect here was that they valued the lesson because it enabled them to understand the content so that they could succeed in the
examination. Typical comments were as follows:

Please continue that way of teaching up to the time when we will have our Junior certificate exams. (S2LEA005)

Today’s maths topic was so nice to me comparing to other topics in the past. ... So it is very unfortunate to [fall] a question like that one. (S2LEA010)

I want to inform you that I understood well about averages and [I] am sure that I will never fail when I meet a question about averages. (S2LEA018)

To say the fact, this lesson I have understand it very well. And, if I am going to fail it on the examination, then it will be my problem. (S2LEA020)

Try to make the lessons very interesting like the one which you have done today. I will never forget averages even when writing examination. (S2LEA019)

Students emphasised that, given any question on averages in an examination, they would not fail it. They appreciated having learnt mathematics in the way they did during the lesson on Average because it gave them confidence in facing the examination. There was little mention about the value of the lesson in terms of having enabled them to gain knowledge about mathematics and its relationship to everyday life. They saw the lesson as meeting their examination requirements.

Dialogue

Table 6.6 shows that 12% (i.e., 7 out of 56) students liked the high level of student talk that took place in the lesson. Students viewed this lesson as different from other lessons since it involved nearly everyone in the classroom. Students felt a sense of freedom to share their contributions and to say anything they wanted.

Indeed it was very nice because each and every student was [able] to give out his or her suggestions. I would like to recommend this. And, I know that this way of learning will [be] profitable to us. The sums which we were arguing [about], the truth came out at the end and we learnt more yesterday. (S2LEA007, emphasis added)

Some students indicated that they liked the discussions and believed that they understood mathematics better when they learned it in this way, that is, by “debate”, “opposition” and “proposition”, than being told by the teacher. They believed that thinking for themselves was more useful and more memorable.

Everyone was able to say what he thinks. ... In connection [with] that I can say that that way of teaching was very good because it can encourage us to think [more] in mathematics than just being told by the teacher. (S2LEA005, emphasis added)

Although there is a sense in which students believed in the existence of a “true” answer to the question, the key aspect here was that students recognised the
value if having “competing” and conflicting opinions which resulted in students spending time “debating” and “disagreeing”. This seems to have made the lesson different from others they had experienced previously, as can be seen from the 43% of the students who greatly enjoyed the lesson. In their opinion, this represented a better way of learning which they wanted to continue in their classroom. The following remarks illustrate this point.

I have to say that today is a non forgettable day in mathematics. It has been a wonderful day since everybody was participating in raising up the points to solve the problems. (S2LEA013)

Today’s lesson was just fine because we were like debating so it was so interesting I wish it was like that everyday. (S2LEA014)

If maths had been simple like this every pupil would have been doing well. (S2LEA049)

For these students, involvement in dialogue was a change in their learning since it concerned a shift from learning from the teacher to one in which students had a voice in mathematics lessons.

This lesson enabled some students to develop a different attitude in terms of the way they viewed themselves in their relationship to mathematics. They experienced a sense of “becoming”, that is, they saw that they could become better mathematicians if they learned mathematics through discussion.

Today’s lesson has encouraged me to put much effort in maths so that in time to come I shall be good at this subject... I have seen that if well understood, it’s easy to be a mathematician. (S2LEA052)

According to the work we have done today, truly it is well understood. And I thank you because of the teaching technique you have used. Today I have made my own decision that now I will be listening carefully [in order] to be one of the [our school’s] mathematician. (S2LEA020)

However, as can be seen in the above comments, students made no explicit reference to the use of dialogue as a way of enabling them to become mathematicians. Rather, they saw themselves as acquiring this status through the use of passive pedagogies — that is, effort (which might mean practising mathematics problems regularly) and listening (which could mean paying attention to what is being said without questioning).

This lesson focused on one problem and used all the forty minutes allocated for the period. As can be seen below, this was satisfactory for some students.

Today’s maths topic was so nice to me compared to other topics in the past. What made me to be so glad was the opposing and proposing of students. I think, how the class was, we took a long time discussing the same question. So it is very unfortunate to [fail] a question like that one because almost everyone was
happy even somebody sleeping would wake up ... because of disagreements between students. (S2LEA010, emphasis added)

However, there was strong resistance from two students who did not feel interested in extended discussions. One of the students made the following remark to demonstrate this.

[The] mathematical lesson was today was fine. But we students, after my own observations, I find that we oppose things which are correct. We lose time in such a habit. For instance, today we have just [been] quarrelling, crushing on an easy problem “average”. Everybody knows what an average is, how to find it. (S2LEA015, emphasis added)

The other student stressed that “there wasn’t [any]thing which [he] didn’t know in the sum since all was straightforward” (S2LEA056).

Due to the apparent loss of time experienced in the lesson, these particular student did not see the value of engaging in discussions, especially concerning facts and definitions whose meaning was obvious to anyone in the classroom. They did not see the need to question their own knowledge. They believed that once the facts were “known”, their knowledge and correctness could not be challenged.

It is also possible that these students had their own agenda, different from the one I had. They possibly wanted to learn mathematics in a way that was consistent with established classroom norms. They wanted to conform to the routine classroom practice which valued content coverage more than discussion. Having a deeper understanding of mathematics and making links with everyday experience were possibly not a priority for these students, and possibly others as well. For them, it was sufficient to know the facts and procedures for solving mathematics problems. They were more interested in the content rather than the context and the process through which mathematical knowledge can be made more meaningful and relevant.

6.2.3.3 The teacher’s perspective on the lesson

As mentioned previously, both TS2 and I taught the average lesson. I taught the lesson in Form 2E, while TS2 taught the same lesson in Form 2N and Form 2W. She was the observer in the lesson in Form 2E, and I observed the lessons she taught. In this section, I describe TS2’s reactions to the lesson. The aim is to highlight TS2’s feelings about the lesson, particularly in terms of her views about the question, the way she felt it needed to be framed, and the extent to which this affected the level of classroom discourse.
TS2 was concerned about the number of options given as answers to the question. In her comments on the lesson in Form 2E, TS2 felt the need to:

- include another option (e): all are correct, since it seems that once they get one correct option, they don't look at the other options. (TS2, Lesson Observation 33, 2/7/97)

She felt that the addition of another option was necessary because she seemed to have observed that the question had generated a lot of debate and, most likely, confusion in some students. The following comments from students appear to have confirmed TS2's concerns.

- Today's lesson was very interesting and I have enjoyed it. Only that [the problems] were a little confusing, but after trying, and understanding [the problems], I saw that they were fine. (S2LEA022, emphasis added).

- I am not clear on how 7, 13 free kicks are found. You mean to say [that] if we take 20 divided by 2, it give[s] 7, 13? Then how? [On] that point I will stick [to] the answer (d). That is to say [that] there are two teams, so I will just multiply $\frac{10 \times 2}{2}$, [to get] 10, 10. If not, clarify the point there. (S2LEA016)

According to TS2, students like those above found the problem difficult because they did not recognise the significance of the word "possible" in the question (TS2, Lesson Observation 33, 2/7/97). She felt that adding another option would avoid the confusion. When she taught the same lesson in Form 2N and Form 2W, she tried to alert students to the significance of the word "possible". Although this had the potential of reducing the level of debate among students, some degree of debate and conflict still took place. For example, in defending their choice of option (d), two students stood up and openly challenged TS2 saying: "Madam, you are wrong" (Research Journal, 2/7/97). By signalling the importance of the word possible, TS2 believed that students would not get confused. However, as the following comments show, some students in her lesson still felt puzzled. This indicated that the question still had the potential to generate dialogue and reflection among students in spite of the hint TS2 had given.

- Today's lesson I feel uncomfortable and felt my head pain because I was think[ing] very hard. (S2LEA047)

- For the time being, [it] still shows that maths is a difficult subject. (S2LEA052)

TS2 attempted to direct them, to make it easier for them. She saw what had happened in the Form 2E class. Her observation of the "chaotic" nature of the previous lesson seems to have made her ensure that she gained control of the situation in her class. She seemed to have been trying to avoid more problematic issues, to avoid conflicting situations prompted by the nature of the question.
Due to instructional pressures such as time, TS2 possibly wanted to follow the classroom norms which required her to direct students to the right procedure for solving the problem. She possibly did not want students to make “mistakes” or realise their own mistake.

TS2 felt that the “vagueness” of the problem was an obstacle in that students would make mistakes in finding the right answer. TS2 possibly saw mistakes as things that get in the way, that is, things that prevented students from becoming the way the teacher wanted — learners who get everything right.

The above analysis shows that we had different views about the goals we wanted to achieve in this lesson. I wanted students to engage in dialogue about mathematics. However, TS2 seems to have been more interested in getting students “on the right track” (Alro & Skovsmose, 1996, p. 2). She wanted them to spend little time arguing, but take shorter routes to the right answer.

### 6.2.4 The research journal

To begin the analysis of the research journal, I entered all journal entries in a computer file. This was important for two reasons. Firstly, it enabled me to manipulate the data and search for key words during the analysis. Also, the research journal contained commentaries and interpretations on various data that would be incorporated directly into relevant sections of the analysis and discussion chapters of the thesis.

I then read all the journal entries and made notes on relevant sections of the data. Key themes began to emerge, and these were given identifying codes. An example of the coding process of the journal entries is shown in Appendix 19. For example, the following extract from the journal illustrates the problem of lack of learning resources frequently experienced when organising teaching sessions at the DEC.

> We often spend more than 10 minutes looking for a portable chalkboard. There is often a scramble for portable blackboards with the primary teachers on occasions when they too have to have their lessons outside classrooms. The DEC has two [portable] blackboards. However, they are usually locked inside the Principal’s office during morning hours when we have our lessons and need blackboards. Chalkboard dusters are also a problem. (Research Journal, 3/6/97)

Entries similar to these were coded “CXT” in order to identify commentaries concerning the general learning “context”. After completing this “rudimentary coding” scheme (Glesne & Peshkin, 1992, p. 130), I then compiled all the data belonging to each category and performed a further analysis on the data to examine for “commonalities, uniqueness, confusions and contradictions in
content, and any missing information” (Tesch, 1990, p. 145). The categories were then combined and refined resulting in eight broad issues. I then developed an index of these categories. The index containing the main categories is shown in Table 6.7 below.

Table 6.7:

Index of Categories from an Analysis of the Research Journal

<table>
<thead>
<tr>
<th>Category</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Learning Context [CXT]</td>
<td>2, 3, 5, 7, 8, 10, 12, 13, 14, 15, 18, 19, 20, 22, 26, 31, 34, 37, 38, 39, 45, 47, 49, 50</td>
</tr>
<tr>
<td>Use of Everyday Experiences [UEE]</td>
<td>2, 3, 6, 9, 16, 17, 22, 30, 32, 43, 46, 48</td>
</tr>
<tr>
<td>Assessment [ASS]</td>
<td>11, 13, 17, 18, 22, 24, 25, 27, 28, 33, 34, 43</td>
</tr>
<tr>
<td>Teachers' Pedagogical Knowledge [TPK]</td>
<td>3, 12, 19, 19, 24, 25, 45</td>
</tr>
<tr>
<td>Teachers' Teaching Practices [TTP]</td>
<td>4, 8, 11, 12, 13, 20, 21, 26, 33, 34, 37, 46, 47</td>
</tr>
<tr>
<td>Working Relationship with Teachers [WRT]</td>
<td>4, 5, 7, 8, 12, 14, 20, 32, 34, 40, 41, 42, 43, 45, 46</td>
</tr>
<tr>
<td>Active/Independent learning</td>
<td>3, 4, 8, 9, 12, 13, 16, 17, 18, 20, 25, 26, 33, 46</td>
</tr>
<tr>
<td>Ethics [ETHICS]</td>
<td>3, 4, 8, 17, 18, 30, 31, 33, 37, 44</td>
</tr>
</tbody>
</table>

The categories displayed in Table 6.7 concerned:

- **the learning context** — these included inadequate classroom facilities and large classes;

- **the use of everyday experiences** — these included problems associated with the use of everyday experiences such as teachers' focus on content rather than on contextual aspects of the topics; teachers' understanding of what constituted everyday experiences; and teachers' attempts to incorporate the use of everyday examples in their classrooms;

- **assessment** — these included teachers' use of assessment to control or manage classroom learning; conforming to the practices of the Malawi National Examinations Board, for example, by repeating previous examination questions on classroom tests and placing more emphasis on certain content areas than others;

- **teachers' pedagogical knowledge** — including their ability to make reflective use of mathematics textbooks rather than following them without considering the context in which they were written; and their ability to link content areas with everyday examples of the concepts;

- **teachers' teaching practices** — being judgmental; being in control and doing more work than students; teaching by exposition;
• working relationship with teachers — differences and contradictions in teaching styles; balance in reporting classroom episodes;

• independent (active) learning — students copying each other’s work during exercises and tests; students’ resistance to become more involved in classroom discussions; discussions and reflections being viewed as a waste of time; and

• ethics — negotiating access to research participants; tape recording interviews; and benefits of the research for the participants.

6.2.5 Issues from the analysis of observation data and the research journal

This section describes the main issues that arose from the analysis of the observation data and the research journal. The issues described in this section concern problems associated with the use of everyday experiences, teachers’ and students’ roles in the classroom, and the influence of assessment and time on the teaching of mathematics in the two schools. Critical incidents from the observations are used to support the discussion of these issues.

6.2.5.1 Focus on content and use of everyday experiences

Most of the lessons taught at the DEC and the SEC did not involve the use of everyday experiences. For lessons in which everyday experiences were used, they played a limited role. Nevertheless, there were some attempts to link topics with everyday experiences in some topics (see Tables 6.4 and 6.5; and Appendices 17a, 17b, and 17c).

As Table 6.4 shows, there were only 20 out of 70 (that is, 28%) lessons in which everyday examples were used. As explained earlier, this happened because the majority of the mathematics topics which the teachers were dealing with were abstract and had very little connection with everyday experience, at least in the way teachers were expected to teach them.

I anticipated that teachers would use some of the suggestions from group meetings when teaching the lessons. However, it seems that teachers were constrained by the requirements of the syllabus during the presentation of the lessons. Their presentation focused more on covering the content than discussing links between mathematics topics and everyday life. For example, in Lessons 63 and 65 concerning the topic probability, TS4 spent very little time discussing issues associated with the everyday meaning and usage of the term “chance”. In planning for this lesson, we spent a significant amount of time discussing
probability ideas associated with populations such as birth rates in Malawi. I anticipated that the lesson would generate a lot of discussion. However, TS4 spent more time going through exercises which were intended to reinforce the discussion and paid little attention to the context in which the exercises were developed.

A similar incident occurred in Lesson 14 when TS4 observed a lesson I taught in Form 4N. In that lesson, we had planned to illustrate the everyday application of the Cosine Rule. We had planned to use the context of bearings. When observing the lesson, TS4 spent more time recording the content aspects of the lesson, for example, the diagrams used, and the discussion episodes which mostly related to content. TS4 noted the following:

The teacher marked North, East, West, [and] South. Pupils volunteered as soldiers... Assuming the starting point is Balaka, what is the bearing of soldier 1 from Balaka? Answer: 45 degrees. Who would like to be a commander? ... From Balaka, move 10 steps at a bearing of 75 degrees... What is soldier 3's bearing from Balaka? [Answer]: 210 degrees. How do we use the Cosine Rule? Can we use the Cosine Rule here? No. ... When finding bearing you must work from the North. (TS4, Lesson Observation 14, 4/6/97)

TS4's focus on content in her teaching was also observed when she taught a lesson in Form 4E (Lesson Observation 16, 4/6/97). In that lesson, TS4 spent more time going through lengthy calculations designed to demonstrate the use of the cosine formula. This resulted in marked periods of silence in the classroom, rather different from what the Form 4N students had experienced in Lesson 14.

The problem of lack of detailed discussion about the use of everyday experiences and content was also observed in TS2's lessons. For example, TS2 just followed the procedure described in the students' textbook: *Secondary Mathematics Book 2* (Gunsaru, 1991, p. 172), when introducing the topic Formulae. While TS2 asked students to give examples of formulae they had used previously (an attempt to link mathematics with what students' already know), questions such as: Where do people in everyday life use the formulae V = IR or I = \( \frac{PRT}{100} \)?; What do the formulae mean for them?; Are formulae important?, were not pursued (Lesson Observation 48, 12/8/97). A discussion of these and similar questions could have prompted the production of "reflective knowledge" (Skovsmose, 1992). This is because such an inquiry had the potential to enable students to ask why they received so little interest when they kept money in a bank account. However, a rapid progression into the content — that is, substitution of numbers into the formula, gave students little opportunity to ask questions of this nature.

The above example illustrates the content of the textbook as a constraint on using everyday experience in the classroom. A similar case was observed in Lesson 54.
(15/8/97) when TS2 asked me to give students the following problem (taken from *Secondary Mathematics Book 2*) as an application exercise for the topic *Formulae*.

The time, $t$ minutes, taken over a committee meeting, is given by the formula $t = 5n^2 + 15$ when $n$ people are present.

(a) How long does the meeting take if there are 4 people?
(b) How many people are present if the meeting takes 2 h 20 min?


By selecting this question, I had assumed that TS2 saw a link to the use of everyday experience. I had expected that she had questioned the meaningfulness of the question in connection with everyday life. For example, in the textbook sense, the meeting would take 95 minutes if 4 people attended. It would also mean 5 people being present if the meeting took 2 hours and 20 minutes.

However, in real life, the situation is usually more complicated than this. It is quite clear that the above problem assumed that all the people in the meeting spoke at the same rate. This is not always the case in everyday life.

However, TS2 chose the above problem because she wanted to give students a problem in which it did not make sense to have a negative answer. In other words, TS2 only considered the value of the problem in terms of its potential to illustrate the content aspect of the problem. TS2 did not see its value as enabling students to discuss the potential, as well as the limitations, of using mathematical formulae to describe everyday reality.

The other problem concerned my expectation that teachers would use everyday experiences when in our planning meetings we had clarified the actual process of how these would be used in the classroom. As an example, in a lesson for the topic *Standard Form*, TD2 and I had planned to use an extract from a newspaper in order to introduce the topic. We discussed the idea that newspaper editors use shorthand notation to write numbers. For example, they write K3.5 m instead of K3,500, 000 million. This was similar to writing $3.5 \times 10^6$ for 3,500,000, in school mathematics notation, that is, using standard form. However, during the lesson, TD2 only showed the newspaper extract to students without discussing the link with the topic at hand. Instead, TD2 quickly moved on to the content of the lesson and followed the procedure and exercises provided in *Secondary Mathematics Book 2* (Gunsaru, 1991, p. 20).

The point here is not to claim that TD2 undervalued the discussion we had planned. However, it is quite possible that TD2 either did not see clearly how he would use the planned discussion in practice or considered it as being useful to enrich his mathematical knowledge as a teacher, rather than as something which
he needed to use in the classroom at that time. The latter possibility is supported by an incident at the SEC when TS2 and TS4 considered newspaper extracts as being more useful for planning their teaching than as a source of extra reading material for students. TS2 and TS4 felt that they needed to keep the newspaper extracts for themselves rather than display them on classroom noticeboards as we had planned. TS2 and TS4 also wanted to use the information from extracts to set classroom tests (Research Journal, 3/7/97).

6.2.5.2 Teachers' and students' roles in the classroom

The analysis of the observation schedules revealed a number of incidents in which teachers dominated the classroom discourse. Teachers often acted in ways which showed that they viewed their role as requiring them to do all the work and leave just enough for students. For example in Lesson 10, TS4 observed that "Not much was done, [the calculations] were left to be completed by students" (Lesson 10, 29/5/97). The implication here is that TS4 viewed her role as one in which the teacher needed to be seen to do their job — that is, explain everything without allowing too much doubt and suspense in students' minds. This dominance of teacher talk often had the effect of making the teachers feel exhausted at the end of the lesson (TS4, Lesson Observation 51, 14/8/97).

For TS2, the teacher's dominance in lessons resulted in her spending little time listening to students' comments. For example, in Lesson 25 (24/6/97), TS2 quickly finished solving a problem herself as soon as one student had given the "right" step in solving the problem. This practice was also common in TD2's lessons. TD2 often made quick comments such as "That one is correct" (Lesson Observation 47, 12/8/97), when responding to students' contributions. This quick judgment had the effect of subverting opportunities for students' engagement in discussion.

Teacher dominance of classroom events resulted in very quiet classrooms. In most cases, the only time students spoke to each other was when they wanted to borrow some writing material from another student (Research Journal, 12/7/97). In such cases, I was often tempted to stimulate some dialogue in the classroom (Research Journal, 14/8/97). This was effective in some ways since it had the effect of initiating discussions intended to question students' observance of mathematical rules (such as BODMAS, any number raised to the power of zero is equal to 1, any number multiplied by 0 is equal to zero). However, intervening in this way was also problematic and had negative consequences. An example of this concerned Lesson 52 (14/8/97) when TS4 did not follow up a question which I initiated. Furthermore, some students reacted in a way that showed that the answer to the question was absolutely obvious.
There were various incidents when teachers and students viewed classroom talk as counterproductive. For example, TS4 remarked “why are you making noise” (Research Journal, 29/5/97) when I was teaching a lesson and had asked students to talk to each other when they needed help in solving problems. TS4 viewed student talk as “noise”. Some students felt that allowing students to talk in lessons meant that the teacher was not taking teaching seriously. For example, one DEC student commented: “Not being serious when teaching made students to make noise while you were teaching” (D2QB025).

Other students believed that listening to the teacher was an effective way of learning and knowing more about mathematics. The following comments illustrate this.

The thing which made me to understand [the topics] I have mentioned is that I was paying attention when the teacher was teaching. In other words, I can say my faith was on what the teacher was saying about mathematics. (D2LEC004, emphasis added)

Today’s lesson has been very good and a nice one because everyone was very attentive. (S2LEE001, 13/8/97, emphasis added)

Today’s maths lesson was very fantastic. The reason was because many [students] were quiet and were paying their attention [to] what the teacher was teaching. It is my belief that if it will continue going [like] this, many of us shall know how simple maths is. (S2LEE002, 20/8/97, emphasis added).

In the activities done in my maths classes, I benefit a lot through being attentive to the teacher. (S2LEB010, emphasis added)

Students often put themselves at the periphery and tended to put the teacher at the centre of classroom discourse. This is evidenced by students who emphasised their role in the classroom as listeners. They believed that they could learn better through listening to the teacher.

These remarks point to transmission as the common method that prevailed in the classrooms, which was rather different from the Average lesson described in Section 6.2.1. Some students assumed this passive role without reflection. This resulted in surface learning and rote memorisation of facts and procedures.

6.2.5.3 Role of assessment

Teachers’ actions in lessons seem to have been influenced by the importance which they attached to examinations. This took various forms. Firstly, TS4 used the examination as a way of keeping students on task — that is, controlling their learning so that students cooperated in the classroom. This concerned disciplining students so that they kept on task. TS4 used the examination as a tool for maintaining her classroom control. This can be seen in the following comment.
TS4 remarked to students: “Do not be quiet. The examination timetable is out. Your friends in the other class have gone far. You are delaying yourselves by not answering”… “Answer please. The exam timetable is out. Your friends have already started Linear Programming”. (Lesson Observation 34, 2/7/97)

Assessment also influenced teachers’ selection of content and choice of problems they used as examples in the classroom. For example, in Lesson 22 (12/6/97), when TS4 gave students some problems to do, she decided to solve one as an example, one which she considered “impossible” or “hard” to solve. The aim was to give students practice in solving “hard” problems.

It needs to be noted here that TS4’s classroom practice seemed to be responding to examination pressure, especially towards the end of the study when students were approaching examination time. Her teaching focus during this period typically reflected her commitment to the examination. For example, she spent more time revising previous examination questions and often became agitated when students could not answer a question correctly. She made comments such as “By the way, when are you writing your exams? You make me feel sorry” (Lesson Observation 56, 18/8/97).

With respect to TS2 and TD2, assessment played a weaker role in their instructional practices. It seems that, since the Form 2 students had more time before they wrote their examinations, TS2 and TD2 were fairly relaxed in their teaching and referred little to the examination both in setting exercises and in managing students.

6.2.5.4 Time

Time was a key aspect which influenced the progress of lessons as well as teachers’ and students’ views about how lessons needed to progress. During teaching sessions, it often happened that teachers taught at a slower pace during the beginning and middle of a lesson. Towards the end when the bell rang to indicate that there were five minutes left before the end of the period, teachers tended to rush their teaching. This often left most of the content crammed in a small space of time. When I was the one teaching the lessons and the teachers were observing, teachers felt impatient and signalled to indicate that I had to stop for the next subject (Research Journal, 17/7/97). The point here is that the forty-minute lesson was often inadequate, especially when we had extended discussions. This led some students, especially the Form 4s at the DEC, not to fully appreciate the value of lesson activities because they resulted in a slow teaching pace. This can be seen in the following remarks.

The learning of maths is quite OK but for exams it’s not OK because the lessons are being taught in slow manner that it consumes our time for
we are late. Had it been that we were in form three it would have been better because we could understand the problems better. (S4LED008, emphasis added)

The comment I can just make is that since we are Form 4s, and our time of learning is limited. We need to cover a lot which we were not able to do so because we lost a term in form three, so the speed need be increased so that we can stand a good chance. We need to cover a lot. (S4LED059, emphasis added)

Students wanted the teacher to speed up teaching in order to cover more content so that students adequately prepared for the examinations. These particular students saw themselves as “examination candidates” rather than learners.

The manner in which students commented about the importance of “speed” in their learning indicates that they not only considered speed as a crucial aspect of teaching, but also viewed speed as a key characteristic of the discipline of mathematics itself. As the following remarks suggest, students believed that the production of mathematical knowledge required speed rather than sluggishness.

The lesson was very slow and need[ed] a little speed but still the lesson was very nice and enjoyable. Let the knowledge of mathematics grow! (S4LEE006, emphasis added)

The topic has been very nice and nicely taught. [The] only one problem [is that] we weren’t time conscious... Let the spirit of maths stick in people though they have stopped learning. (S4LEE008, emphasis added)

This lesson has been greatly enjoyed. The teacher was also happy. Today we were time conscious. Maths is really [present] in everyday life. Let’s make maths live for ever. (S4LEE008, emphasis added)

Time and speed seem to be a well-celebrated aspect of mathematics, according to these students. For these students, time defines the spirit of mathematics.

It needs to mentioned here that students’ reference to speed as a key aspect of mathematics learning might relate to the way teachers are required to teach mathematics. For example, the teaching guide for Geometry (Ministry of Education, 1987), advises teachers to stress the following to students:

[As a] means of success, daily work should be done rapidly. Cultivate speed in your work by not making mistakes that have to be searched for and corrected. Cultivate speed by concentrating on your work and not allowing your thoughts to wander. Remember: neatness promotes accuracy; accuracy promotes speed. (p. 95, emphasis in original)

However, it needs to be pointed out here that the “speed” factor associated with mathematics teaching favours those students who may be considered to be “naturally intelligent” (S4QA006) and alienates the “mentally-sluggish” student (S4QA051) from the subject.
6.2.6 Summary

The analysis of the observation data has indicated various problems associated with the use of everyday experiences in teaching mathematics in the two schools. Firstly, very few lessons involved the use of everyday experiences. This happened because of two reasons. The first concerned the nature of the syllabus topics with which the teachers were dealing. The topics were abstract and difficult to link with everyday experience, especially within the constraints of time and resources in the two schools. Secondly, in lessons which used everyday experiences, the use of everyday experiences played a more limited role than I had expected. Teachers focused more on teaching aspects which involved covering content, rather than making extended connections of the content with everyday experience.

The analysis has shown that the use of everyday experiences had some potential to improve students' learning in mathematics. This can be seen from students' comments on the lesson of Average described in Section 6.2.1. The use of everyday experiences had the potential to engage students in discussion. However, the fact that very few students explicitly made comments on the everyday context used in the lesson indicates that they were more concerned with aspects of learning which were more directly related to their "conventional" role as learners. Students' frequent focus on success confirms this. However, this might be expected since students, as well as teachers, were responding to the requirements of the teaching context rather than the broad learning perspective which I had expected them to assume.
6.3 Reflection on the use of everyday experiences: Teachers’ perspectives

As described in Chapter 5, I organised meetings with teachers during which we reflected on various aspects of the research process such as planning, teaching and observation of lessons, the aims of the research and issues that emerged from the broad teaching context. Altogether, I had eight discussion meetings with TD2 and fourteen meetings with both TS2 and TS4. At the conclusion of the research process in the schools, I conducted individual interviews with each of the three teachers in order to collect information about their teaching backgrounds, perceptions of their mathematics teaching and the effects of the research intervention on their classroom practices and students’ learning. The discussion meetings and interviews were tape recorded resulting in more than 40 hours of tape-recorded material to be analysed.

I transcribed all final teacher interviews. Due to time limitations in the data collection process, I often made brief summaries of tape-recorded discussion meetings. However, I made detailed transcriptions of some recorded meetings which had covered pertinent issues concerning the research, such as the role of assessment in the teaching and learning of mathematics, and problems of doing classroom research and involving teachers as researchers in their classes.

This section has two purposes. Firstly, it describes the analysis of the data from discussion meetings and final interviews with teachers. The analysis began with the data from the final interviews. This is because the final interviews focused on aspects of teaching and learning which were central to the research investigation. These were: teachers’ views about mathematics teaching, the effects of the intervention on teachers’ classroom practices and students’ learning, and constraints to change in mathematics teaching and learning.

Secondly, this section describes the results of the analysis of final interviews and notes of discussion meetings with TD2, TS2 and TS4. The descriptions are presented as cases for each teacher on the following aspects: teaching background, classroom practice, and perspective on change. The section describes the case of TD2 separately from that of TS2 and TS4 because, although the three teachers belonged to the same education system, TD2 taught in very different conditions from that of the others and had a very different educational background.

The final component of the section describes the major issues arising from the description of the three cases.
6.3.1 Analysis of interview transcripts and notes of meetings

To begin the analysis of teachers’ data, I found Tesch’s (1990) notion of an “organising system” useful. Tesch defines an organising system that is derived from research questions, concepts used by other authors, the data themselves and interview questions in order to determine analytical categories. Tesch describes the operation of this process as follows:

- Data are “segmented”, i.e., divided into relevant meaning “units”, yet the connection to the whole is maintained. The analysis always begins with reading all data so as to provide a context for the small pieces.
- The data segments are categorised according to an organisational system that is predominantly derived from the data themselves.
- Categories for sorting segments are tentative and preliminary in the beginning; they remain flexible (Tesch, 1990, pp. 95–96)

I used Tesch’s notion of an organising system in the analysis of the teachers’ data because the teacher interviews (see Appendix 9) were organised around three central questions concerning the research investigation. Broadly viewed, these questions related to the following issues:

- teachers’ teaching background and their orientation to mathematics;
- teachers’ views about teaching and planning processes;
- teachers’ perceptions of the effects on the research intervention on their classroom practices and students’ learning; and
- possibilities for and constraints to change in mathematics teaching and learning.

I first read all the data from a transcript (see Appendix 20 for a sample) in order to “get a sense of the whole” (Tesch, 1990, p. 142). I segmented the data according to the above organising issues. An example of the segmented version of the data is shown in Appendix 21. After segmenting the data into the above broad issues, I chose not to code the data nor develop categories as I had done with the other data such as responses from student questionnaires. This was due to two conditions concerning the nature of the teachers’ data itself. Firstly, it was quite clear, upon reading the data, that the teachers responded differently to the questions. One teacher’s data was therefore not the same as the other’s data, although it was collected using the same questions and the teachers, particularly TS2 and TS4, were in the same context. Hence it was not appropriate to use a category identified from one teacher’s data to analyse another’s. I therefore chose to deal with each teacher’s data on a case-by-case basis.
Secondly, the teachers' data was conversational. The data arose from a dialogue between me and the teachers. The most appropriate way to analyse this data was to "dialogue" with it — that is, interrogate and interpret it. Figure 6.8 below shows an example of this process. The first task was to identify what the issues were and then identify the components of the issues. I then recorded my comments beside the data.

By working with the data in the above way, I was also able to ask further questions related to the data and sometimes go beyond it. For example, I asked: Why is TD2 focusing on the examination? What forces lead him to this orientation to teaching? Why does he now find it important to expand his focus about teaching mathematics? What can be discerned from this in terms of how students responded to the questionnaires and how they performed in their mathematics examinations?

In this way, I wanted to make links with the context in which teachers were responding to the interview, for example, what their students said about mathematics and how they thought mathematics learning could be improved. I assumed that the teachers' statements represented the way they made sense of mathematics and their experiences in teaching it. At the same time, I considered that a teacher's understanding of mathematics teaching was not static but represented a fluid set of conceptions. Teachers' conceptions of mathematics teaching depended on what they did in the classroom, what others said to them and how they thought about their actions and the actions of others. By interrogating the data in this way, I allowed the analysis to be open to various view points and to be linked with other data sources.

The analysis of the teachers' data produced a collection of commentaries, insights and quotations which were then re-arranged according to the issues described above (that is, teaching background, classroom practice, and perspectives on change) in order to begin to tell a story about each of the three teachers.
<table>
<thead>
<tr>
<th>Extract of transcript</th>
<th>Issue/Sub-issue</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD2: At first I had in my mind that we just teach in order for them to pass, not for them to acquire knowledge, but we just teach in order for them to pass their exam... And after you came, and after doing some sort of teaching and whatever, it's when I realised that OK I was trying something wrong. Because I was [concentrating] on &quot;how can I teach them so that they [should] pass their exam?&quot;</td>
<td>Perspective on change</td>
<td>TD2 believes that there is something else that is also important about teaching mathematics apart from preparing students for the examinations. He sees that teaching is important so that students can gain some knowledge which they can use in business, to seek employment, as well as gain knowledge of mathematics for its own sake.</td>
</tr>
<tr>
<td>WM: So you had the exam in mind?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TD2: Yah.</td>
<td>A shift from focusing on the examination to teaching for knowledge.</td>
<td></td>
</tr>
<tr>
<td>WM: So now [you feel] you should be doing something more?</td>
<td></td>
<td></td>
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<tr>
<td>TD2: Something more. Apart from the exam we have to teach them so that they will use it in their everyday life.</td>
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<td></td>
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<tr>
<td>WM: Do you find that important?</td>
<td></td>
<td></td>
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<tr>
<td>TD2: Yah ... There are others who just want knowledge, because maybe they won't be employed so they would like to do business and the like. And to say the truth, I was trying very much for them to pass. Because I remember a certain day, after the release of last year's examinations ... the Principal said, &quot;You see here. This is mathematics. Can you see, the highest [score] was D [Pass], the rest of the students got F [Fail]. So please you should watch out. This is now your turn&quot;. So I had a picture that &quot;how can I teach so that many students should pass with good marks?&quot; (TD2, Final Interview, 5/9/97)</td>
<td>Perspective on change</td>
<td>There are institutional conditions which influence TD2 to teach in the way he does. In other words, these remarks from TD2 are coated with beliefs and elements about what is seen as acceptable goals and understanding about what is good teaching or effectiveness of a teacher.</td>
</tr>
<tr>
<td>TD2: I had a wrong mind because at first I thought for students to know mathematics very well, it is himself [the student] putting in more effort towards that subject. The teacher can make the students to like that subject... I took it that I have to plan and teach them clearly, emphasising points after points, so that each and everyone got the right information. In so doing, them the students will like the subject. The way you teach the subject can make many of them to follow [the material]. (TD2, Final Interview, 5/9/97)</td>
<td>Putting more effort into teaching</td>
<td>TD2 initially believed that it is the sole responsibility of students to succeed in mathematics, and that this can be achieved largely by effort. It is possible that his conception of teaching is coloured by his knowledge about the regulations governing his institution, which advocates self-study and the importance of putting effort into learning (eg, by constant practice: see, Malawi College of Distance Education, 1986, p. 1).</td>
</tr>
<tr>
<td></td>
<td>Perspective on change</td>
<td>TD2 now believes that he, as a teacher, can make students like the subject, and by implication, succeed in mathematics. He also believes that teacher's effort is necessary for students to succeed in mathematics.</td>
</tr>
<tr>
<td></td>
<td>Putting more effort into teaching</td>
<td>This also underscores the shift TD2 experienced. However, in addition it also reveals what he expects to be his role as a teacher and the corresponding role of students.</td>
</tr>
</tbody>
</table>

Figure 6.8: A scheme for analysing teachers' data
6.3.2 The case of TD2

This section describes the results of the analysis of the final interview and notes of discussion meetings with TD2. The description involves the following aspects: TD2's teaching background and orientation to mathematics; his classroom practice; and his perceptions of the effects of the research intervention on his practice as well as students' learning. As will be described below, TD2 claimed that there were some changes in his thinking about mathematics teaching and the way students felt about learning. However, rather than considering these as providing evidence of change in actual practice, the aim of presenting TD2's case is to provide a context for discussing the possibilities for and constraints on changing mathematics education in Malawi.

6.3.2.1 TD2's teaching background and orientation to mathematics

I interviewed TD2 in order to collect information about his educational and teaching background and how these affected his approach to mathematics teaching.

As summarised in Table 5.1 (see Section 5.1.4), TD2 was trained as a primary school teacher. He did not have any specialised training in mathematics. His highest qualification in mathematics was Form 4. TD2 had two years of experience teaching Arithmetic at primary school. According to him, he felt confident about teaching Arithmetic. As can be seen from the remarks below, TD2 describes himself as someone who was confident at teaching Arithmetic, and more able to teach it than any of his colleagues in the primary school at the time.

During that year, the headmaster wanted me to [change] from teaching in Standard 6 to Standard 8, because there was no one who knew Arithmetic very well. It was only me. When the headmaster learnt that I had moved to another school [DEC], it was very painful to him. (TD2, Final Interview, 5/9/97)

As described in Chapter 2, teachers at most DECs in Malawi are recruited from the existing pool of teachers in the primary system. Mostly these are teachers who are seen to be the best at the primary level, and who have the potential to teach with some confidence at the DEC level. However, when TD2 joined the teaching staff at the DEC, he did not see himself as competent enough to teach at that level. He was not even briefed on what he was expected to be doing in his new role, nor given any inservice training to enable him to teach effectively at this level. TD2 makes the following comments:

When I went to the DEC ... I was just given a mathematics [booklet], two [notebooks] for lesson plans and schemes [of work]. So I was
stranded [and said], "How can I plan?" There was no briefing. He [the Principal] just said "Here is your [textbook]. You will be teaching mathematics". (TD2, Final Interview, 5/9/97)

Nevertheless, as the following comments suggest, TD2 could be described as "someone who knows mathematics".

Upon reporting for duties at the DEC, the Principal asked me what subject I was going to teach. I said, "mathematics". The Principal wanted someone who knows mathematics. So that is why it worked. So I started teaching at this DEC ... in 1995. (TD2, Final Interview, 5/9/97)

TD2 found it difficult to teach mathematics with his current level of knowledge about the subject. For him, the knowledge that he had about mathematics was from his experience as a learner in secondary school.

It's difficult ... I am using the knowledge which I got from my secondary school... I am just implementing the knowledge I got from my teacher. (TD2, Notes of Meeting, 12, 30/7/97)

At the time of his participation in this research, TD2 had been teaching mathematics at the DEC for two years. Over this period, he saw himself as having developed some confidence in teaching the subject. TD2 was now teaching Form 2, which was an examination class. He stressed that he could only claim to have gained enough teaching competence when he found out how many of his current students passed the national examinations. For TD2, getting students to pass the mathematics examination was a symbol of effective teaching.

I don't have much experience [teaching] at the secondary level because I have only taught Forms 1 and 2. After they [have] written these examinations, then I will know where [I] stand. (TD2, Final Interview, 5/9/97)

As previously mentioned, TD2 was not briefed about what he was expected to do as a member of staff at the DEC. However, the policy of the Malawi College of Distance Education expects TD2 to be a supervisor of student learning — that is, a teacher-supervisor, rather than a formal teacher. According to Malawi College of Distance Education (1996, p. 9), teacher-supervisors are signed up primarily to "present educational materials". They are not expected to be "competent teachers". However, TD2 did not see his role in this way. Because of the conditions at the DEC — for example large classes — TD2 saw himself as a "teacher" rather than a "supervisor".

Nowadays we are forced to teach not to only supervise ... We are not supervisors, we are teachers ... I think it's better to teach ... Teaching is [more] helpful than supervision, because there are many [students] there. [If each one of them] brought his or her own problem ..., you can't manage to help [all of them]. Maybe there will be favouritism — the teacher favouring some students. It would happen [that] may be you [make] private deals if someone came with money
and [said], "I don’t understand here". So you [focus] on that one, leaving [your] normal work. (TD2, Notes of Meeting 12, 30/7/97)

TD2 also believed that teaching needs more knowledge than the supervisory role he is expected to assume. In supervision, "most of the work is done by students" (TD2, Notes of Meeting 12, 30/7/97). The role of the supervisor is just to provide guidance.

Although the policy of distance education did not expect him to teach formally, TD2 saw himself as a teacher and therefore needed to teach rather than supervise student learning. As will be seen later, TD2’s apparent lack of teaching experience in mathematics influenced his classroom practice as well as the way he viewed his participation in the research.

6.3.2.2 Classroom practice: Aspects TD2 considers when planning to teach

During the interview, TD2 emphasised time and assessment as two aspects he considered when planning to teach a particular lesson. As described below, these seem to be important aspects of his overall classroom practice.

Time

When asked to describe the kind of planning he did for his mathematics teaching, TD2 placed emphasis on the amount of time allocated for a particular lesson. "You plan according to time" (TD2, Final Interview, 5/9/97). As the following comment shows, TD2 is time conscious and makes sure that his lesson does not use more time than allocated on the school timetable.

WM: Do you have any principles that guide you in your teaching? Do you have something which sort of makes you to teach the way you do?

TD2: In fact the [teaching] principle maybe will come. But on my side there is no [teaching] principle. Because you can say that I will just do this in order to please someone, or I will never do this in order to please someone, but on my side, I have no principle. I just teach when there is free time. Not to sacrifice myself to teaching. For example you find that the first [teaching] period is mine, I will teach. After that there is nobody to go inside [the classroom]. So I cannot say I want to go in again because I want to make myself to be a good teacher. No, I will never do this in order to please someone. (TD2, Final Interview, 5/9/97)

Although TD2 did not seem to consider himself as having a teaching principle, he appeared to be using the rule "follow the timetable" as a guide in his planning and teaching. TD2 wants to ensure that his lesson plan follows the allocated time during which he is supposed to teach. He does not want to teach more than expected. He does not want to use another teacher’s period (to cover more
content), even if there was no teacher in the classroom at the time. In TD2's terms, doing more teaching than expected would amount to being seen as a good teacher.

TD2 seems to be responding to the requirements of the teaching system which has a fragmented time schedule in which lessons take place in fixed time slots, as Pendlebury (1998, p. 347) puts it. TD2 does not want to interrupt the schedule but follow it. Acting contrary to the schedule, for example by using up more time than expected, risks him being called a "good teacher", by which he might mean being viewed as a better teacher than those in the system. The teaching principle for TD2 seems to be a basic but important and context-related one of "follow the schedule", although he does not seem to view it as such. He seems to be committed to "following the rule" since he says: "I will never do this in order to please someone".

Assessment

As might be expected, giving exercises is an important aspect of TD2's teaching practice. For TD2, exercises (problem solving) help him check whether he has clarified the mathematics content for the students.

After a lesson, you have to give them an exercise to assess them so that you have an idea that this topic is clear for them. Because, in mathematics, you cannot teach and teach without giving them an exercise. (TD2, Final Interview, 5/9/97)

For TD2, exercises are an essential component of mathematics teaching. "In mathematics, you cannot teach and teach without giving them an exercise". However TD2 does not comment on the form the exercises need to be and how they need to be developed. Nevertheless, as the following suggests, the aim of giving exercises and "activities" for students is to clarify the mathematical content — to make sure that the students are "following" what TD2 is saying.

After looking at the topic, I try to see "is this topic relevant to another topic?" Or can I use any activity so that the students should be following? (TD2, Final Interview, 5/9/97)

The above remarks suggest that TD2 consciously plans his teaching. He checks if the topics are following a sequence so that they are seen to be part of a system rather than disconnected bits of content. However, it is not clear whether this is designed to promote understanding of mathematical concepts. Whether by "following" he means "following the authority of knowledge" is also open to speculation. For instance, it is not clear whether the "activity" is aimed at opening up space for questions.
6.3.2.3 Perspectives on change: Effects of the intervention on his practice

In this section, I describe three key aspects in TD2’s classroom practice in which TD2 claimed there was some evidence of change. As described below, these involved aspects about TD2’s knowledge of mathematics, his views about assessment, and his role in the classroom. However, it should be noted here that the change in TD2’s practice represented a beginning in TD2’s reflection about his practice rather than a change in the actual practice. This is because, apart from the short time frame in which the research was conducted, establishing change in classroom practice is generally seen to be a complex process.

**TD2’s knowledge of mathematics**

“I am just gaining knowledge from you”.

TD2 claims to have gained knowledge of mathematics as a result of his participation in the research. As can be seen below, this might be expected considering TD2’s previous educational background and lack of inservice teacher education to enable him to teach effectively at the DEC level.

There are some areas — when I say areas I mean topics — which maybe I didn’t get clear during my secondary level. So it is very difficult to teach those topics. So with your assistance, it’s when I am coming up to know those topics. I am just gaining knowledge from you. (TD2, Final Interview, 5/9/97)

Participation in the research represented a learning process for TD2. TD2 needed some assistance to plan teaching activities. Additionally, and perhaps more crucially, he needed to see how the activities worked in practice so that he could learn from them. For TD2, gaining knowledge by itself did not constitute an end but a beginning of the process of learning to teach. In TD2’s terms, it was a learning process that was also characterised by a degree of uncertainty — whether he was teaching using the “right” methods.

**TD2:** [I need] more help on activities, from you ... . Being primary trained, I find it tough.

**WM:** How would you like me to work with you?

**TD2:** Teach the whole lesson once so that I can learn... . “How do you look at me when teaching? Do I follow the right procedure?”

(TD2, Notes of Meeting 5, 4/6/97)

However, this learning process seemed to be highly dependent on input from the researcher: “I am just gaining knowledge from you”. Although this was expected given the lack of professional support TD2 gets from the DEC, TD2 also saw the role of the researcher as one that was about critiquing practice. It was important
for TD2 to gain knowledge so that he could teach confidently. This is emphasised in the following remarks:

You were talking about planning together. It's what I wanted because I feel good to plan together .... There are some areas which I can say I don't know. Once we plan together, to my side I gain knowledge before the students. So once I present that lesson I use that knowledge I get from you .... I had problems concerning certain areas. So you elaborated and said this and this. So once I go there and teach I really know where to tackle, and it's good because I know it before the students. So once the students ask, I can answer with no doubts. (TD2, Notes of Meeting 12, 30/7/97, emphasis added)

TD2 felt that planning lessons together was beneficial as it enabled him to gain more knowledge and anticipate students' questions. However, the gain in knowledge needs to be reflected upon and examined critically. As can be deduced from the above remarks, TD2 may have felt more confident since he had gained more knowledge of mathematics. Although TD2 considered this enabled him to adequately prepare to teach and answer students' questions, it is possible that TD2 considered himself as possessing more knowledge than the students. However, in TD2's terms, teaching requires more knowledge than is required by supervision. In this respect, TD2's view about his current level of knowledge of mathematics seems to be related to his belief about teaching.

**A shift from focusing on the examination to teaching for knowledge**

"How can I teach them so that they [should] pass their exam?"

TD2 indicated that he experienced a shift in the level of emphasis he placed on assessment when teaching mathematics. This can be seen from the following remarks:

At first I had in my mind that we just teach in order for them to pass, not for them to acquire knowledge, but we just teach in order for them to pass their exam .... And after you came, and after doing some sort of teaching and whatsoever, it's when I realised that OK I was trying something wrong. Because I was [concentrating] on "how can I teach them so that they [should] pass their exam?" (TD2, Final Interview, 5/9/97)

The above remarks raise a number of issues. Firstly, they show that TD2 experienced a significant shift from a focus on teaching for examinations only to teaching to enable students to acquire "general knowledge" as well. Secondly, TD2 believes that teaching in order for students to pass the examinations is an established practice in schools. In addition, this idea comes from a need to fulfil students' needs: to enable them pass the examination. He is determined to see that students pass the examinations. Thirdly, participation in the research provided a stimulus for TD2 to think about his teaching focus — that is, to re-examine mathematics teaching in broader terms than previously considered. It
can be deduced that TD2 now considers the general question: what else should students be getting out of learning mathematics if they do not do well in their examinations? The following remarks illustrate this.

WM: So you had the exam in mind?

TD2: Yah.

WM: So now you feel you should be doing something more?

TD2: Something more. Apart from the exam we have to teach them so that they will use it in their everyday life.

WM: Do you find that important?

TD2: Yah ... . There are others who just want knowledge, because maybe they won’t be employed so they would like to do business and the like. And to say the truth, I was trying very much for them to pass. Because I remember a certain day ... after the release of last year’s examinations ... the Principal said: “You see here. This is mathematics. Can you see, the highest [score] was D [Pass], the rest got F [Fail]. So please you should watch out. This is now your turn”. So I had a picture that “how can I teach so that many students should pass with good marks”? (TD2, Final Interview, 5/9/97)

It is quite evident from the above remarks that the broad teaching and administrative contexts put pressure on TD2 to focus on the examinations. The DEC Principal told TD2 to “watch out” — to make sure that more students passed mathematics. However TD2 thinks that, in order for students to succeed, they need to understand more and have more general knowledge.

TD2 sees that the research activity did not disadvantage his classroom practice. Rather, involvement in the research assisted TD2 to teach mathematics so that his students understood the subject and were prepared for the examination.

WM: Don’t you think that not many of them will pass the examination since you are now also doing other things there?

TD2: No. They will pass because what we are doing, what I am doing, it’s a part of the examinations. I don’t [concentrate] on examinations only, but they [students] have to have general knowledge. Because once they have general knowledge, they will use that knowledge during their examinations ... And even myself, I am expecting to have a number of them, even though a small number, maybe one of the students to have an “A” or “B”. In so doing the Principal will be pleased. Because last year we had no C, no B. (TD2, Final Interview, 5/9/97)

The remark: “In so doing, the Principal will be pleased” suggests that the goals TD2 had for teaching were not necessarily his goals. TD2 was fulfilling the goals of the institution in which his classroom practice was located. This might seem to contradict what TD2 partly holds as his teaching principle: “not to please anyone by sacrificing myself to teaching”. However, it seems that the “ends” (examinations), for which the Principal is mostly concerned, appear superior to the “means” — teaching. TD2 wants to be judged as a good teacher (most likely
by the Principal) on the basis of students' examination results rather than on the teaching activity itself.

**Putting more effort into teaching**

TD2 now realises that he needs to put more effort into teaching in order that students succeed in or like mathematics.

I had a wrong mind because at first I thought for students to know mathematics very well, it is himself [the student] putting in more effort towards that subject. The teacher can make the students to like that subject ... I took it that I have to plan and teach them clearly, emphasising point after point, so that each and everyone got the right information. In so doing, the students will like the subject. The way you teach the subject can make many of them to follow [the material]. (TD2, Final Interview, 5/9/97)

The above represents a shift in TD2's thinking about his practice — putting more effort into teaching. However, this shift is at the “technical-instrumental” level (Kemmis & FitzClarence, 1986, p. 103). It is at a technical level since it is concerned more with delivery: “teaching clearly”, stressing “point after point” to make sure that students know mathematical facts rather than understand what mathematics is about. It is also technical, because “following” is not the same as “opening up spaces for questions”. Although TD2 claims that putting more effort into teaching will lead to students generating more interest in mathematics, it seems to be mostly a matter of ensuring that students pass the examinations.

However, on its own, putting more effort into teaching was a worthwhile change for TD2 considering the highly demanding teaching role imposed by overwhelmingly large class sizes and inadequate learning facilities at the DEC. The task of teaching mathematics in these conditions was seen to be so demanding that some teachers could just sit and wonder about what to do as a result of being overwhelmed by the situation. However, from a students' perspective, this may be viewed as laziness, as can be seen from the following student's comment:

I am asking the Ministry of Education to give us good qualified teachers. They must encourage teachers not to be lazy just as they are doing now. They just come here and sit outside drinking their minerals (coke and fanta) forgetting that they are teachers, [and] they came here to teach us. I will be glad if this problem is going to be solved. (D2QA178)

**6.3.2.4 Perspective on change: Effects of the intervention on TD2's students**

I held discussions with TD2 in order to explore TD2's perceptions of the effects of the research intervention on students' learning. Although TD2 claimed that he had noted some improvements in the students' learning, he viewed these mostly
in terms of students having gained more knowledge of mathematics due to having had more time to learn and practise solving mathematics problems.

**Students gained more knowledge**

TD2 felt that students gained more knowledge as a result of their participation in the research. This was a result of having covered more mathematics content than would have been the case if TD2 had taught lessons alone.

Now, they are just saying we have gained more knowledge. So for me, our coming in the morning has helped me and we have covered a lot. And the students themselves are just appreciating ... . Even if I chose to stop [teaching them] now, they can't really complain. They even say that for the things we have covered, when they checked with the [previous] examination [questions], most of the areas are there. Everything is there. So why should they say I have not taught? (TD2, Final Interview, 5/9/97)

The above comments highlight three points. Firstly, that the students gained more knowledge which was important for the examination. Secondly, for TD2, having covered mathematics content which was examinable proved that his teaching efforts were worthwhile. The third point, which is related to the first two, is that students gained more knowledge as a result of having had more time to learn, and having been taught more regularly. This can be also be seen from the following:

WM: For those students who have improved, what do you think has made them improve?

TD2: I think it's because of us — going there in the morning, afternoon, morning, afternoon. So for them, they are trying hard so that they should do something, and having more time to practise. (TD2, Final Interview, 5/9/97)

Because of having been taught more regularly, more students became encouraged to write mathematics assignments than before.

[I've] more assignments to mark now .... About everybody. Once I give work to write at least everyone writes .... Now it shows that at least they are coming up. Better than in the previous ones. (TD2, Notes of Meeting 12, 30/7/97)

TD2 observed that more students were turning up for classes than previously. TD2 says:

Since we have started [the research], I think things have gone well during the morning classes due to participation, more [participation] according to turn-up. It means that they really mean it .... In normal (afternoon) classes, the turn-up was good just because they want to learn some subjects but concerning maths [it was] poor .... . There was less turn-up in mathematics classes in the afternoons, but more [students] in morning classes. (TD2, Notes of Meeting 5, 4/6/97, emphasis added)
Student attendance in mathematics lessons improved mostly because there was an increase in learning time for mathematics. In needs to be emphasised, as shown in Table 5.1 (see Section 5.1.4) that the teaching conditions at the DEC, particularly regarding time, were far below what would be considered adequate for effective learning. Each of the two Form 2 classes at the DEC had five forty-minute periods a week in the afternoons. The forty-minute periods were insufficient to enable TD2 to teach effectively, especially given that he had about 160 students in each class. However, since TD2 was teaching an examination class, he arranged to teach extra lessons during morning hours so that he could cover more content than was possible during the forty-minute periods in the afternoons. Consequently, students seem to have seen an opportunity to learn something, because there was now more time than in the normal (afternoon) school hours. In Pendlebury’s (1998) terms, the morning hours provided uninterrupted or “continuous time” space for learning as opposed to the tight and fragmented schedule students experienced in the afternoon lessons. As expected, students seem to have liked this new arrangement. TD2 says the following:

I asked them: as of now, how do you feel? They said, “No, let’s continue [learning] in the morning”. Because I was suggesting that I want to (stop) coming in the morning. I just wanted to find out their feelings. They said, “No, please keep on coming”... [They] were saying ... it is better to learn in the morning just because they are still fresh ... Learning has changed because in the morning we have enough time. (TD2, Notes of Meeting 5, 4/6/97)

However, the extra lessons resulted in a heavy teaching load for TD2. At one stage during the research process, TD2 found teaching so tiresome that he considered reducing the number of teaching hours. However, he reversed his decision after reading a summary of students’ comments about the lessons. As can be seen below, students emphasised the fact that they became interested in mathematics and understood it because they now had more time to learn, and the teaching was not as rushed as it often occurred during the afternoon lessons when there was little time.

In this subject, I feel well and I love it. At first I met some problems [in] it, and I was [about] to leave mathematics. But the time you started teaching us in the morning, little by little I see some changes and I believe that it is an easy subject. [To] add on that, the way you are teaching us, I see that you are explain[ing] well because at first I was failing to solve any problem in mathematics. But as of now, I am trying to solve. So please don’t stop helping us even [if] sometimes we do bad things like [making] noise. (D2LEC001, emphasis added)

The part[s] of mathematics which I [understood] well this week [are] Algebra and Geometry. This recovery is due to our teacher for being available to attend morning classes. This made me to [do] well in mathematics. My learning of mathematics is now moving on its channels when I am comparing with the [previous] days. And I am
sure that if our teacher will not [leave] us within two months to come until the end, I will pass this coming examinations. So I am wishing him all the best so that he can encourage us to attend morning classes. (D2LEC002, emphasis added)

The thing is that all the topics of mathematics which we have learnt this week or last week I understood well. [It] is because you teach in the morning. We come to school in the morning without any trouble, that's why I understand well ... I am feeling well about my learning in mathematics because [it is] taught slow slow. That's why I feel well about my learning in mathematics. (D2LEC011, emphasis added)

For students, it is quite clear that having more time to learn was critically important as was teaching effort and, most likely, the fact that they now had the assistance of another teacher: the researcher. As can be seen below, the students wanted the researcher to spend more time with them than the two days a week that was allocated. When I asked TD2 about how students felt about our working relationship, TD2 said:

I think it is encouraging. Once you came and introduced to those students then in their mind, I think they are open. Meaning that you will assist them in teaching. And to see me teaching with you together with you, I think they enjoy it. And they were saying that you have to be coming regularly. Rather than coming twice a week. So they told me to tell you that you have to come. (TD2, Notes of Meeting 5, 4/6/97)

The above remarks are supported by one student who, in response to the first student questionnaire, said the following:

I [would] like to know about [how] your mathematics is, and I want one person to help me to solve the mathematics. And I was happy to see someone like you to help me. (D2QA137)

For the above student, and most likely for others as well, the role of the researcher was to help them learn so that they would be able to solve mathematics problems.

6.3.2.5 Summary

To summarise the case of TD2, the above analysis has shown a number of things. Firstly, time was an important aspect TD2 considered when planning to teach. Time was linked to a number of institution-related aspects such as "following the school timetable" and assessment. Secondly, TD2's thinking about teaching and mathematics was strongly tied to the context in which he was working. The administrative role represented by the Principal, put pressure on him to teach for the examination. Also, TD2 did not want to teach frequently because of fearing to be considered a better teacher than the others.

Participation in the research stimulated TD2 to re-examine his thinking about mathematics teaching. He considered it important to expand his thinking about
his teaching focus: he now found it important to focus on teaching to enable students to gain knowledge and use it in their everyday lives as well as to pass the mathematics examination. TD2 also realised that it was important to put more effort into teaching. In so doing, students felt that they learnt more and were given adequate attention.

The above aspects indicate that TD2 began to reflect on his teaching practice. However, a number of constraints impinging on his practice need to be addressed. For example, lack of time, the influence of assessment and TD2’s perception of how other teachers viewed his role are constraints which have been outlined in the analysis and will be discussed further in later sections of the thesis. However, it is important to stress here that lack of time and assessment were key issues which TD2 highlighted as needing most attention and which would prevent students from fully appreciating the value of using everyday experiences in teaching mathematics. This can be seen from the following remarks:

The activities are helpful only that there are number of problems like time. These activities need more time, more time to hold the activities .... They (students) even come up saying that concerning the activities, they are more helpful but it needs time as I said already and they were saying that this should be for Forms 1 and 3 because they will have enough time to practise and whatsoever. But not Form 2s because they are expecting to have examinations. So if they delay with some activities, they will be behind the syllabus.

It’s [would be more] helpful had it been it was [from] Form 1 up to Form 2, because once you only introduce it in Form 2, there is a shortage [of] time so it won’t be seen that it’s helpful because they are rushing, they are working against time.... And some teachers even recommended [it] because I was talking to my friend and telling him telling him what we are conducting and again he was saying this should be introduced to the Form 1s so that them they will participate more rather than these Form 2s because they are against time. They will be writing examinations. (Notes of Meeting 12, TD2, 30/7/97)

6.3.3 The cases of TS2 and TS4

In this section, I describe the cases of TS2 and TS4 in terms of their teaching background, classroom practice and perspectives on change. Instead of describing the cases separately as I have done for TD2, this section describes the cases of TS2 and TS4 simultaneously for two reasons. Firstly, the two teachers were in the same school (that is, at the SEC) and taught similar students, although they were in different classes — that is, Form 2 and Form 4 respectively. Secondly, all my discussion meetings with TS2 and TS4 took place when both of them were present. The only exception was in the final meeting when I interviewed the two teachers individually. Because of this, the data from TS2
and TS4 contained some episodes in which TS2 and TS4 responded to each other's comments in ways that revealed similarities and differences in their thinking about mathematics teaching and learning.

As was the case in Section 6.3.2, the primary intention of describing TS2's and TS4's cases is to provide a context for examining possibilities for and constraints on changing mathematics education in Malawi.

6.3.3.1 Teaching background: Differences in the education of TS2 and TS4 and their orientations to mathematics

Information about teachers' background is shown in Table 5.1 (see Section 5.1.4). Both TS2 and TS4 attended university and had done mathematics up to at least second year of university. TS2 did not have any formal teaching qualification, while TS4 had a Bachelor of Education. Nevertheless, in terms of the requirements for teaching mathematics at secondary school, TS2's and TS4's background were much better than TD2's.

TS2 and TS4 expressed confidence about teaching mathematics. However, as described below, TS2 and TS4 liked mathematics for different reasons.

TS2: At secondary level I used to like mathematics. That was my favourite. [However], I found statistics better than mathematics when I went to college.

WM: Why did you like mathematics at secondary level?

TS2: At secondary, it wasn't too abstract for me. I was able to understand it. But when it came to college, it became abstract and sometimes I couldn't see its application in real [life]. Since I was looking [for] a career that [would] suit me, I [looked] at the applications of what I was doing. So I lost some interest and I diverted to statistics. (TS2, Final Interview, 10/9/97)

TS2 liked mathematics at secondary school. When she came to the university she found mathematics abstract, although she claimed that she could succeed in it if she had continued studying it. TS2 became more interested in studying statistics because it was more applicable and in line with her career interests than pure mathematics. For TS2 therefore, mathematics did not appeal to her because it lacked connections with reality and most crucially, her career aspirations.

On the other hand, TS4 liked mathematics because of reasons deeply related to the nature of mathematics itself, particularly in the ways of working with mathematics. For her, the methods of mathematics were "obvious" and "true" because she believed that one always "works from the truth" in mathematics. She felt that, in mathematics, the answer comes from somewhere; from logic.

WM: What is it that really catches you about mathematics? Is it just that you like it naturally or there is something else about it?
TS4: I can say I like mathematics naturally, but also the fact that when I have a problem and I try to solve it, I see that it follows logically. It follows logically, and when I come to the final answer and I try to check it, it is obvious [and] true.

WM: So you just find that mathematics follows naturally and there is logic in it?

TS4: Yes, there is logic in it and I am doing a thing which is true. (TS4, Final Interview, 8/9/97, emphasis added)

TS4 believed that mathematical knowledge is objective and uncontested (true) since it follows from the rules of logic. TS4 was able to establish its truth by following the methods of arriving at an answer. In mathematics rather than other subjects, TS4 clearly saw where the answer — the knowledge — was coming from since she believed that mathematics has a beginning and an end.

[In other subjects] I couldn’t see where the answer is coming from. Of course they could have the correct answer, but I couldn’t [see] where it was coming from. For example, I could have the correct formula [for a chemical compound] but I couldn’t [see] where it was coming from. That is why I said that I was not working from the truth. With mathematics I can see where I start and where I am finishing. There is some logic. I feel that this answer is coming from somewhere. Of course with science you can see from the experiments, but with chemistry I didn’t see where it is coming from. (TS4, Final Interview, 8/9/97)

As can be seen from above, TS2 and TS4 had different views about mathematics. While TS2 found mathematics interesting because of its concreteness especially at secondary school level, she found tertiary mathematics abstract and disconnected from reality and her future interests. On the contrary, TS4 found mathematics interesting primarily because of it nature. It is logically true. TS4 saw mathematics as “coming from somewhere”.

6.3.3.2 Teaching background: Differences in TS2’s and TS4’s views about teaching

TS2 did not have any formal teacher education. Although teaching wasn’t her intended profession, she joined it because it was the only job she could immediately find at the time.

I had to find some employment. I had to earn something. Something that came to my rescue was teaching. But of course sometimes in life one doesn’t realise what a career can offer. So it’s when you are in [it] by accident or whatever, that you realise that it’s also a good career. (TS2, Final Interview, 10/9/97)

TS2 joined teaching without any instructions about her role as a teacher. She remarked: “All I got was an offer, a letter of appointment from the Ministry of Education” (TS2, Final Interview, 10/9/97).
Although she did not have any teaching qualification, TS2 appears to have some principles that guided her teaching approach. For example, TS2 realised that the mathematics curriculum she was dealing with was different from the one she experienced as a secondary school student. It was not something that she could teach in the same way that she learned. Although she felt the mathematics was the same, TS2 viewed it as different since it was in a different institution. It was a changing curriculum particularly in terms of the people who were using it.

It is different where one is teaching what one was taught, or the way one was taught. Now being in a different institution, with a different syllabus, although mathematics may be the same, we have to look at the curriculum. It's a different curriculum. The approach might be different from the way our teachers [may] have taught us. (TS2, Final Interview, 10/9/97)

However, TS2 stresses the importance of following the curriculum — that is, teaching mathematics within the expectations of the syllabus. She had to teach what the institution required students to learn. As can be seen below, following the curriculum was a key aspect of TS2's beliefs about teaching.

TS2: If you look at the way they have defined the syllabus, I find that they have a topic and then they say: "[By] the end of this topic students must be able to do this and this ...." What I have found out is that in textbooks for the Junior Certificate level, the topics are displayed in such a way that they take care of what they are supposed to get at the end. So the examples are in such a way that they give you or they give them [students] what they should get in the end.

WM: So you find that the textbooks tell us what students are supposed to get?

TS2: No. They don't tell you in black and white to say what they should be getting, but when you read the example you get the [picture] that from this example they want the students to get this and that. (Notes of Meeting 8, TS2 & TS4, 24/6/97, emphasis added)

TS2's views about teaching mostly related to her interpretations of the requirements of the curriculum and teaching situation — that is, what the education system required and emphasised. For TS2, teaching seems to be about giving students the knowledge which she expected them to receive. TS2 described teaching as "making people know things which they didn't know" (TS2, Final Interview, 10/9/97). TS2 accomplishes this task by following the textbook.

On the other hand, TS4's ideas about teaching had strong links with her previous education, that is, her experience as a learner in secondary school and university.

At secondary school TS4 wanted mathematics to be taught by one teacher so that she could get used to her approach and follow it. She found being taught by different teachers disturbing. Nevertheless, she maintained her interest in mathematics because she had mathematics textbooks which she followed alone.
TS4's experiences at university were similar. For her, it was important for the teacher to present mathematics in such a way that it followed logically. As might be expected, this was important so that she could succeed.

WM: What about when it came to college [university] level, how do you look at the way mathematics was taught?

TS4: Even though it was different mathematics, it was taught rightly. The material itself was well presented. Even when it came to exams I was able to tackle three-quarters of the problems. I didn't [face] many problems with it. (TS4, Final Interview, 8/9/97, emphasis added)

TS4's beliefs about ideas following logically were influenced by her understanding of education principles, particularly those from psychology.

WM: What were your experiences in other education courses, the curriculum and teaching studies, how do you look at how these were taught?

TS4: In philosophy of education, I didn't see the logic because [the lecturer] could touch here and there, and if you tried to connect the information, you could see that it is difficult to connect, especially in philosophy. Other parts it was OK. Because in psychology, they are studying students, their behaviours from stage to stage. We could see those things happening so we could see these are true. It follows logically. The [lecturers] were making a connection with a student, that when you are teaching a student, you should see this happening. We started with Piaget's theory, studying a child from birth to adolescence. So you see these changes happening. Then when you go out, we were seeing those things. (TS4, Final Interview, 8/9/97, emphasis added)

Three key aspects of TS4's view about teaching emerge from the above remarks. Firstly, the issue of being able to follow the content; secondly, that TS4 saw mathematics as being taught rightly since it was presented well; and thirdly, that what she was learning was following logically. There was truth in it and she could see it. TS4, having found that the psychology of education was compatible with her teaching beliefs, confirms the above aspects of her views about teaching. According to TS4, the presentation of content needs to follow a progression — from stage to stage. For TS4, teaching seems to be about accurate presentation of mathematical content so that students are able to follow it and see the logical connections between ideas. TS4's views about teaching indicate a strong relationship with her experiences as a learner.

6.3.3.3 Aspects TS2 and TS4 consider when planning to teach mathematics

The use of mathematics textbooks and reference to examination requirements were key aspects that emerged in TS2's and TS4's descriptions of their classroom practice.
Role of the textbook

In accordance with her teaching beliefs as described in the previous section, TS2 looks at the curriculum and what it expects students to learn, when planning to teach. In particular, TS2 looks at the range of mathematics examples presented in the textbook. She then looks at the problems listed in an exercise and chooses one of them as an example. The main aim is to give students experience in solving different problems — that is, to expose students to several worked examples apart from those given as examples in the textbook.

TS2: In a typical situation, before I go to class I look at what I am going to present to them. So I look at different types of examples in the textbook which might be covered by that topic. I choose which ones I am going to use as exercises and which ones to use as examples.

WM: So you use your textbook.

TS2: Yah... To me the textbook was my guide of what they are expected to [learn]. I found the book was a sort of a guide. The way the examples were [given].

WM: You have the examples already, so you would just choose?

TS2: I choose from the exercises. I don’t choose the examples [which are already there]. (TS2, Final Interview, 10/9/97)

TS2’s approach typically follows a “traditional” routine. However, she seems to be reflective about this, since she does not consider mathematics as procedural — that is, following prescribed steps. For her, doing mathematics is about application and problem solving.

What I have is that all they [students] do is look at mathematics as something that is procedural. You have steps which you have to follow for a problem. Not that they have to reason, to think [about] what they are writing [rather] than just following the way the examples have been laid out. So given a problem, they follow the same steps. I found out that that’s what they were doing, following steps. So that’s why I prefer giving them an exercise which is a bit different from the example because I don’t want them to follow [everything]... I try to give them something which is a bit different, [concerning] the same concepts, so that they don’t just follow my example. But they should think, because I expect [them to] have understood my example. They should be able to apply it [to] a problem. I don’t look at mathematics as just following steps, but it’s problem solving. (TS2, Final Interview, 10/9/97)

As can be seen from above, TS2 was very critical about students following textbook examples as guides for solving mathematics problems. She wanted students to think beyond the examples she gave them. Although this indicates that TS2 was flexible about her use of the textbook, her general approach still reflected her teaching beliefs since according to her, she had to follow what she expected students to learn.
TS4’s views about the role of the textbook were similar to those described for TS2. For TS4, textbooks and other related materials need to be considered to enable students to get the “right” information. However, TS4 regarded the textbook as intended to be a resource mainly for the teacher and to be used sparingly by the students. She stressed that students should use textbooks only when practising mathematics problems and not refer to them during teaching sessions, since this would distract them from paying attention to her.

**TS4**: When you are teaching they [students] don’t have that chance of using them. They use the textbook for reference. They will not normally use the textbook but it is for you the teacher.

**WM**: So those textbooks are mainly for reference.

**TS4**: For students to refer to them. You just pick a problem, not the already solved example. You just pick a problem from the questions in the textbook. Then you do it as an example. Then after that you tell them this topic is from such and such a book on such and such a page. I would say go and refer to such and such a page... They can check and then I encourage them to say: please practise [so that they] relate those problems to these examples. But don’t use it [the textbook] in the classroom. Because the problem there is that when you say open page so and so, and then you try to write down an example on the board, most of them will not listen. They will just be interested in reading the book. So that is why I am not often using the textbook in the classroom. (TS4, Final Interview, 8/9/97, emphasis added)

It seems clear that TS4 wants students to listen to what she is telling them — that is, to listen so that they can follow the material presented instead of referring to the textbook. TS4 sees the textbook as a distraction rather a resource that could facilitate her teaching. Although she recognises the shortage of textbooks in her classroom, she stresses that students do not normally need to use them because, in her view, the main role of students in the classroom is to pay attention to the teacher. It is evident here that her main role is to remain in control of the classroom discourse.

The materials are for the teachers, especially for the teachers. We need to have the material from where you can pick the information. You can just go in the classroom and give them the material that you have, [you as] the teacher. So I think these (materials) are most applicable [for use by] the teacher. (Notes of Meeting 8, TS2 & TS4, 24/6/97)

**Role of the examination**

As might be expected, since TS2 was teaching an examination class, she considered examinations an important aspect of her teaching. However, TS2 claims that examinations are not her priority because she has not yet mastered the examination system itself.
WM: What other aspects do you consider when planning your teaching? Covering the content?

TS2: Yah. Of course, being exam-oriented you also look at what is expected in an exam.

WM: Is that your priority?

TS2: No. Unfortunately it is not my priority because I don’t have an experience in the exam itself. I haven’t had a wide experience. So all I do is just follow the material which is there. Whether I do something which is too difficult [and may not] be examined in the Junior Certificate (JC) examinations, [I don’t check]. But what I am interested in is students understanding the concepts.

WM: So you mean that if you had more exposure to the JC examination then ...

TS2: Maybe I would be more examination oriented. (TS2, Final Interview, 10/9/97)

An important consequence of her not having fully mastered the examination system is that TS2 is able to accommodate other aspects in her teaching such as teaching for understanding.

TS2 viewed the examination as a separate entity from the actual teaching process. Her comment below suggests that she considered the examination to be an end of, rather than a means for effective classroom discourse. She believes that the examination needs consideration after “covering” the content rather than during the presentation of the content itself.

In my case when you are in an examination class, somehow you have to think towards what they expect at the end because you want them to pass. Now when you are teaching one may be biased towards the common areas which [appear] in an exam. So somehow it affects the teaching. But not really when you are presenting the information.

(Notes of Meeting 8, TS2 & TS4, 24/6/97)

On the other hand, TS4 considered the examination as a very crucial aspect of her teaching plans. When planning lessons, TS4 makes sure that the mathematics exercises include problems that are “examinable” — that is, problems of the type that the final examinations are likely include. She accomplishes this by checking previous examination papers, and searching for topics that the Malawi National Examinations Board places most emphasis on.

TS4: When planning I always make sure that when I am teaching a topic, I have to include a problem that will be examinable.

WM: So you made sure that ...

TS4: I made sure that I have to do a problem which is examinable.

WM: What do you mean by that?

TS4: [By] that I mean the problem maybe included on the exams set by MANEB [Malawi National Examinations Board].

WM: How do you normally ensure that?

TS4: We have access to MANEB past [examination] papers. Then we go through the questions. Then we come across a question under
that topic. Then we know that this topic is examinable in this way. So when I go to the classroom, I make sure that, I need to give examinable examples when I give an exercise. So I make sure I include one problem or two which are examinable.

WM: So you would normally take them from the exam papers.

TS4: No I just check the areas where they [the Exam Board] emphasise on that topic. Then I select a question from the book, and change some numbers because most of the textbooks have got answers. When you give them a problem from the book they just copy down the answer from the back of the book. So I just change the figures. (TS4, Final Interview, 8/9/97, emphasis added)

TS4's teaching plan conforms to the requirements of the assessment system. For her, previous examination questions appear to set a standard for her teaching practice. Although she seems to be reflective about the role of textbook exercises, this is only in as far as their answers remain hidden so that students do not copy them. The examination tests students' ability to get the right answer.

As can be seen below, it is possible that TS4 saw a possibility for teaching for general knowledge. However, TS4 emphasises that the pressure of the examination does not allow her to teach for general knowledge, especially considering that she does not have enough time to cover the topics so that students adequately prepare for the examination.

The teaching system in Malawi is exam oriented. Had it been we were teaching the subject for the sake of making them [students] to know I think we could have covered a wide area. But I think we have a limitation due to examination so we are after that goal... . It is too late for the Form 4's. So if I have to go at a small pace to cover the remaining topics, it is too late. As of now I want to cover the topics that are remaining for examinations' sake. (Notes of Meeting 8, TS2 & TS4, 24/6/97, emphasis added)

TS4 stressed the necessity of training students to work rapidly through mathematics exercises because they were preparing for the examination which allowed them very limited time.

They [students] have to be fast, because they are given limited time. When it comes to examinations, they are given limited time. So if you train them to be slow, then that one will affect them when it comes to examinations. (TS4, Final Interview, 8/9/97)

The above remarks indicate that following the examination is an established practice in TS4's institution. However, this might be expected because she was teaching Form 4 students who are expected to write national examinations.

6.3.3.4 TS2's and TS4's classroom practices

This section presents TS2's and TS4's accounts of how they viewed their teaching practices. In particular, the section describes what TS2 and TS4 considered to be
their main role as well as what they expected students to be doing in the classroom.

**TS2's classroom organisation**

TS2 described her teaching practice in the classroom as typically involving the introduction of a topic, followed by examples to illustrate the topic. She then gives students mathematics problems to solve. During teaching sessions, she expects students to assume a listening role.

WM: Could you describe your main role in the classroom?

TS2: Well, it's either if I am just starting a topic I have to give an introduction of the concepts which are there. Then I give an example. Then I give them some questions to try, problems to solve. Or if it's a continuation of a [previous] topic, I try to make them remember what we covered. Then give more examples covering the different concepts, expanding [on] the concepts we covered previously. Then again I give them examples and then exercises.

WM: What do you see as the main thing students should be doing in the classroom?

TS2: When I am introducing [a topic] and giving examples, I expect them to listen... I want them to follow what is happening. They should be listening to what I am saying... If they have a problem [question] they should put a hand up and say we don't understand there. (TS2, Final Interview, 10/9/97)

From the above remarks, it is important to note three key aspects of TS2's classroom practice. These are: review of previously covered content to make sure that students can recall it; presentation of the new mathematics content and ensuring that students follow what is being presented; and students contributing a question only when they have not understood something. These three aspects seem to characterise TS2's approach as expository and one that puts the teacher at the centre of classroom activity. Ultimately, it is an approach that ensures that the teacher controls the power relationships in the classroom. As the following remarks suggest, TS2's approach may contribute to students having limited freedom to learn.

WM: How would you ensure that everyone is participating?

TS2: Sometimes after I say something, I would pose a question in relation to what I have said, to see if they were attentive, to see if they would be able to answer [a question] in relation to what we have just covered.

WM: I could see that you often hand-picked some students.

TS2: I am doing it deliberately so that they should be awake. So that everyone can see that everyone can be asked. So not necessarily because they are not listening but I can choose anyone not just those with a hand up. But there are times when I would choose [someone] because he/she is outside the class... I pick one whose hand is up, but there are times when I pick anybody. Because I feel that in that way, everybody expects to be asked...
There are some who will be dreaming and they know that you can't pick them because they haven't raised their hand. So they might be out of class... They are supposed to be following what is happening in class. Unless we can say [that] in a democracy one can choose to listen [or] not. But we expect those in class to be listening. If they don't want, why not go out? (TS2, Final Interview, 10/9/97, emphasis added)

As can be seen from the above, for TS2, the aim of questioning in the classroom is to capture students' attention; to make sure that they are staying on task and following what the teacher is saying. In other words, the purpose is to monitor students' cognitive presence in the classroom. It seems that questioning in the classroom has a subsidiary role rather than one that intends to stimulate dialogue among students about various aspects apart from those covered in the classroom. It is likely that TS2 sees the classroom as a different situation from other contexts which observe democratic practices. TS2 expects her students to cooperate in the classroom.

On the other hand, TS4 felt that students were actively participating in the mathematics lessons when they were raising their hands.

When I am teaching I make sure that they are [actively] participating when I ask them a question and I see hands, then I [know] that this one would like to [answer]. But those who would not raise up their hands, I would just mention them, then I find that they fail to give the information. So I saw that [students] were [actively] participating when they were raising up their hands. (TS4, Final Interview, 8/9/97)

TS4's approach demonstrates a different type of classroom control from that described for TS2. In the case of TS4, it is one that coerces students to actively participate in the lesson.

WM: So how did you make sure that the others are actively participating?

TS4: I mentioned their names. Or else when I went to the class I would say "When I ask a question, I don't want to see anyone raising up their hands". I would just start from there [the first row] asking [them] to answer. So [they] should stand up and answer.

WM: I remember in one of the meetings you said it's not normally allowed.

TS4: Yes. It's not normally allowed but when you warn them that I will start from here, that is allowed. But when you ask a question and you mention a name of anyone who is not raising up a hand, that is not allowed. Because it's like you are taking him by surprise.

TS4 seems to be submissive to her teacher education principles which recommended asking only those students who raise their hands to answer a question. Her teacher education courses emphasised that
When you ask a question, you should pause. They have to think. When you choose a person at random who is not raising up a hand, it's like you are choosing him before you have given him time to think... But if you have given him a chance and you see him playing, that is allowed. Maybe he is not paying attention. So you should mention him so that he should know that I am seen not to be paying attention. (TS4, Final Interview, 8/9/97)

You cannot choose someone whose hand is not up... You have to choose that one whose hand is up... That one may have an idea, whether it is wrong or right. Because if you are choosing someone whose hand is not up, it is like you are taking him or her aback, by surprise. (Notes of Meeting 8, TS2 & TS4, 24/6/97)

For both TS2 and TS4, the aim of asking questions is not particularly about stimulating dialogue about ideas related to a topic or lesson, but it is generally one that intends to find out if students can recall information — that is, to reproduce rather than produce knowledge.

**TS4's classroom organisation**

TS4 described her teaching in the classroom as typically involving the following: review of work previously covered; introduction and explanation of new content, followed by a presentation of illustrative examples and an exercise. When some students do not understand the content, TS4 repeats the explanation of the examples or gives students another example. Very little classroom activity involves group work.

WM: Could you describe how you organise your teaching in the classroom. How have you been organising your classroom?

TS4: The proper organisation is when you go in the classroom, you [check] for pre-requisite knowledge by asking some questions about what you have covered with them previously. Then when you introduce [a new topic], you write down the topic on the board. You start explaining what it is, then give an example. Now if you want to see how this information is obtained, you have to divide them into groups.

WM: So you would divide them into groups.

TS4: Then give them a problem to discuss.

WM: So that is how you typically organised your [teaching]?

TS4: Yes. But that is not always. On certain days you go there you explain, and you group them. You just write down the example on the board and you ask if it is well understood. Now if they say yes, you go on. If they say no, you repeat the example and explain it.

WM: So if the class says yes ...

TS4: Yes, it's well understood, you go on. You give them an exercise. But if the majority says no, you repeat the example or you find a different example which will be well understood. Then you write down that, and you try to explain that. (TS4, Final Interview, 8/9/97)
As can be seen from above, TS4 places much emphasis on presenting the mathematics content, to make sure that the students have understood the content. The teaching process is mostly one way, with students contributing to the lesson only when they have a question.

TS4's classroom organisation was consistent with her beliefs and knowledge about teaching. She constantly referred to "pre-requisite knowledge" as an important aspect when beginning lessons. According to TS4, a consideration of pre-requisite knowledge ensured that there was a logical connection between "new knowledge and old knowledge" (Notes of Meeting 8, TS2 & TS4, 24/6/97). The pre-requisite knowledge being referred to here mostly related to content — what students remembered about a specific topic — rather than an exploration of other connections that might be useful for discussing the topic.

**TS4's teaching principle: surveying students' attitudes**

As a first step to consider when beginning a lesson, TS4 stressed the importance of establishing if students were ready to learn and showed interest in the lesson.

WM: Do you have some principles which guide you in your approach to teaching?

TS4: What I do is when I go into the classroom, they will greet me always, and then I would greet them. Then I tell them to sit down. Then I look around the classroom to see the attitudes of the students. If the attitudes [are] not all that [good]...

WM: The attitudes to you?

TS4: Yes, Yes... . If their faces are not happy then I will try to create a joke which will make them happy.

WM: So you want to teach them when they have accepted you?

TS4: When they have accepted me, and they have interest. They are ready to learn whatever material I have brought for them. So when I went to the classroom, I would see the attitudes. If it was not [good] then I [would] create a joke and then they will laugh. After that then I will say, "Let's go to our business". That joke is like a motivation, to bring them back from whatever was hindering them. (TS4, Final Interview, 8/9/97)

As can be seen from the above remarks, TS4 "surveys" the classroom in order to establish whether students are ready to receive knowledge. For TS4, arousing students' interest mostly aims at getting students' attention so that they can follow her presentation rather than sustain active participation and interest in the lesson. It appears that TS4's main aim at the beginning of the lesson is to achieve control of the classroom. The aim is to make sure that she gets students' cooperation as quickly as possible so that she can continue with the teaching task. TS4's remark "They are ready to learn whatever material I have brought for them" strongly suggests that she considered students as passive recipients of knowledge rather than active inquirers.
Again, TS4 attributes her teaching approach to her experiences in teacher education which emphasised the importance of checking students’ mood in the classroom.

WM: Do you find the knowledge that you gained from your teaching studies related to your approach to teaching?

TS4: Yes. The main thing is that you have to know the attitudes of the students ... before you start a lesson. Do not shout at them, because shouting will make them not to receive whatever you are giving them. (TS4, Final Interview, 8/9/97)

TS4 found the knowledge she gained from her teacher education very useful to her teaching situation and strongly felt that teachers who had not attended a teacher education course were at a disadvantage.

There is a disadvantage on their part because they don’t know methodology, the approach itself. Because we see some of the teachers go there [in the classroom], they start teaching and if the students fail to answer a question, they never go back to ask why he or she is failing... They will just shout [and] shout. (TS4, Final Interview, 8/9/97)

Both TS2 and TS4 had similar views about planning and organising their teaching. TS2 had some flexibility on the role of the examination. However, both of them were generally submissive to the requirements of the examination.

6.3.3.5 Perspective on change: Effects of the intervention on TS2’s practice

This section describes TS2’s perceptions of the effects of the research intervention on her teaching practice. TS2 viewed herself as having changed mostly in terms of the effort she put into teaching. In addition, TS2 became more reflective about her role as a teacher.

Putting more effort into teaching

Over the period of the research, TS2 felt that she had to put more effort into teaching than previously. This made her realise that teaching can be an interesting activity.

WM: Do you see yourself as having changed in some aspects of your thinking about teaching?

TS2: Within this period of working together, I have come to realise that if you put in a lot of, more effort, I think it [teaching] could be an interesting career. Because if you plan your work well and you are organised, you find it interesting. And students appreciate what you are doing. Because one of the differences which I can single out is that during this period I have been trying very hard to prepare for my lessons, other than previously. So I think that has made an effect on my output as well. (TS2, Final Interview, 10/9/97)
Participation in the research enabled TS2 to learn more about teaching. She is aware of the differences between theory and practice, that is, she recognises that learning about mathematics teaching in teacher education is a different situation from actually implementing teaching ideas in the real classroom. TS2 also developed a heightened awareness of her role in the classroom. She now planned her teaching more consciously than before.

WM: So there is a change in terms of the effort that you put into teaching. Could you say more about that?

TS2: Yah. Maybe I was lazy. Now I was doing the right thing. That is why I was saying [that] the reality makes people behave in a different way. Because if you consider what we have been doing, I think those are the differences they [have] when you are doing your Bachelor of Education. They use experiences which students can visualise and so on. But when it comes to real life [in the classroom], there are other factors which hinder you from doing what you learnt. Now if you don't have those factors, or you try as hard, you are not lazy to say I will just see what will happen there, you find that things will be OK. But it's the realities which impose some other problems in the classes. Because sometimes they say you have to prepare teaching aids, you have to do this and that, they assume that you always have time to do those. Or you won't get tired. You will have time to do them in class. But when you come here you find that sometimes you can't use those [aids] or you can't give them enough time to try on their own because the time is not there. There are so many things that you have to cover. (TS2, Final Interview, 10/9/97)

TS2 having found the use of everyday examples a useful approach in her teaching is of particular importance here. At the same time, TS2 saw that the use of everyday experiences had enormous practical consequences. Given the complexity of TS2's teaching role, especially her need for time to prepare lessons and engage in other teaching activities, her participation in the research was evidently demanding and, in TS2's terms, an activity additional to what she normally did. The approach of using everyday examples demanded her to think about other ways of presenting the mathematics content that were different from mere reproduction and following textbook procedures.

WM: Could you say a little bit more about what really made you put more effort?

TS2: Because we were using examples, everyday examples. Now that effort was extra from what I would normally do. Because previously maybe I would just look at the example which was in the book, whether it's a real one or not. So I would just look at the concepts of that, not relating it to real life. But in this [approach] I had to think of a real-life example, where it is possible.

WM: So this was sort of an added activity.

TS2: Yah. It was an added activity on my part. And then when you go to class, you have to find something from them as well. While
previously we would explain something, give an example then they do an exercise.

WM: So previously you wouldn’t fit in ...

TS2: Real life. I never, no I wouldn’t relate to it in terms of what is the applicability of this. There were times where something would just come up ... where you could easily find an example. But in our case we would try as much as possible to say can we find an example? So you try and find it. If you fail, you just use the normal way. (TS2, Final Interview, 10/9/97)

TS2 showed readiness to accommodate critique of her practice. She described herself as having a “flexible mind” — that is, an orientation to teaching that was responsive to the reality of the classroom. TS2 was open to interruption and suggestions. However, she saw the value of her effort mostly in terms of its effects on students’ learning. According to TS2, her students became more interested in mathematics.

I think I have been putting more effort and I have also learned a lot from the comments which I would get. As I said, if you go with a flexible mind to say if this doesn’t work, I might get a comment to say maybe you should have done it this way. I think that is better than if I did it. I think it has been quite OK. To see the effects on the students, they were getting more interested in the subject. (TS2, Final Interview, 10/9/97)

Putting more effort into teaching was a positive development for her, and represented a shift from following the textbook which she believed made her aware of what she expected students to learn. TS2 also realised that students could also contribute something to the lesson rather than only follow what she is teaching. It was also a shift from putting more effort in terms of thinking more about the connections between mathematics and everyday life. However, as can be seen below, such a shift in thinking about teaching mathematics could not be considered separately from the constraints of her teaching situations, particularly time and assessment.

TS2: The problem which I found there, I should say is time. That is why I was saying the reality is not the same because if we just look at the time factor, you do some demonstration, something which they can see. And maybe they do it themselves so that it sticks to them, it works better. But when you come to the real situation, you find that you can’t do that because you have to think of what you have to cover by the end of the year, before they write their examinations. So sometimes you choose just to lecture.... That made the teacher to go through something quickly without looking at the other approach which would have been better. So sometimes you don’t look at the approach but you are looking at the time factor there.

WM: So time was one of the things that affected the way you taught.

TS2: Yah, because so many times you would say I think you rushed there. I had to finish because I didn’t want to cover the same things for so many days. (TS2, Final Interview, 10/9/97, emphasis added)
Although TS2 felt that her students were getting more interested in mathematics as a result of active involvement in lessons, time and examination pressures often forced her to “lecture” in order to cover more syllabus content.

6.3.3.6 Perspective on change: Effects of the intervention on TS4’s practice

TS4’s perceptions of the effects of the research intervention on her practice were similar to those described for TS2. However, TS4 considered herself as having changed mostly in terms of the type of problems she gives students as exercises.

Use of everyday examples

TS4 claimed that she changed in some aspects of her teaching practice over the period of the research. She viewed this change mostly in terms of her being able to use everyday examples in her teaching.

WM: How do you feel about your thinking about teaching now?
TS4: My teaching has been improved. I can say [it] has been changed. Because formerly I was not giving them everyday examples. I was just taking an example from the book, then explain it to them, and then give them an exercise. But the time we started this project, I saw that my teaching [has] changed tremendously. I was able to use everyday examples. Not only examinable [problems] but also that technique of applying to everyday life. So [in] some of the areas [in] which I was weak, I have improved... . Previously, I was giving them problems only, not examples. Problems only, when I was teaching them. [But now] I give them problems which are used in everyday life and problems which are examinable. But when it came to examples, during the time when we were working together, I was able to give them more practical examples as well as examinable problems. (TS4, Final Interview, 8/9/97)

As can be seen from above, the change in teaching being claimed was mostly associated with assessment. TS4 claims that the problems and exercises she gave students were previously more of the type that closely related to examination requirements — that is, examinable problems. She now felt that she was giving students mathematics problems which had some connections to everyday life.

It is important to note here that it appears that TS4 does not claim to have abandoned her focus on examinable problems. Rather she treats both examinable problems and practical examples as important. The remark “I was able to give them more practical examples as well as examinable problems” illustrates this point. However, as can be seen below, it appears that there are two ways in which TS4 viewed the use of everyday examples. The first concerns an increase in the number of worked examples — that is, examples of solved problems which
illustrated the mathematical content. The second concerns some discussion about the application of the content to everyday life.

WM: So at first it was mostly problems, but now it is [examples]. Could you say a little bit more about what you mean by examples, because an example can be an example of a maths problem?

TS4: Yah, it can be. But what I mean there is that the problem [is that one] written on the board and we solve together with the students... That is what I mean by an example.

WM: So now you were giving them more examples?

TS4: Yes, yes. More examples, both practical and examinable. That is what I mean by an example. I myself being the head of the class, talking, talking, explaining that problem. That is what I mean by example ..., explaining the topic more. Because before starting this project I was criticised that I was just giving them one example and then several problems. That is why they said the questions were not related to the example given... The problem was [that] I was giving them a single example and then several problems. (TS4, Final Interview, 8/9/97)

Although TS4 seems to have recognised the importance of linking mathematics topics with everyday life, she saw this link as aiming mainly at communicating and clarifying the mathematics content rather than stimulating dialogue among students. The remark “I myself being the head of the class, talking, talking, explaining that problem” illustrates this.

The approach of using everyday examples was also consistent with TS4’s beliefs about students’ role in the classroom — that is, to “catch ideas fast”.

WM: If you were to describe the most important aspect of what you have personally gained from the project, what would it be?

TS4: It would be the use of everyday examples. The use of everyday examples to explain more problems... I will be giving them more examples and also problems to practice. Both more examples and also questions to practice on their own.

WM: How did this approach of using everyday examples fit in your pattern of working in the classroom? How did it affect how you handled the classroom?

TS4: The use of everyday examples helped me to give out the information and the students were receiving the information with more interest. Because they were connecting the information with whatever they see, and it is real. It is real working. So the use of everyday examples was making my teaching fast.

WM: So they would catch the ideas fast.

TS4: Yes.

WM: And you would really want them to catch the ideas quickly.

TS4: Yes. (TS4, Final Interview, 8/9/97, emphasis added)

TS4 found the approach of using everyday examples useful to her mostly in terms of its potential to accelerate her delivery of the mathematical content. The approach suited her teaching principles: to teach the content as fast as possible
and to enable students to grasp mathematical facts with speed. Clearly, TS4 viewed the use of everyday examples marginally in terms of its potential to facilitate dialogue and interaction among students. The role of the use of everyday experiences here was mostly about enhancing knowledge transmission.

As might be expected, TS4 attributed the change in her teaching to the collaboration between herself, TS2 and the researcher.

We were sharing ideas. Because before starting this, I was having my own ideas, not from you my fellow teachers. But from your ideas and from her [TS2's] ideas, I could connect them, then try to improve in the areas of my weaknesses.... The sharing of ideas is what helped me to change. (TS4, Final Interview, 8/9/97)

Although it is likely that the research was also an added activity for TS4, it was consistent with the needs of her students since they wanted more mathematics examples.

6.3.3.7 Perspective on change: Effects of the intervention on TS2's and TS4's students

TS2 and TS4 felt that there were some changes in the way students viewed mathematics, and to a limited extent, in the way they participated in mathematics lessons. However, both TS2 and TS4 felt the need to consider students’ performance in the examinations as well.

Change in students' attitudes to mathematics

When TS2 described the effects of the research intervention on students’ learning, she emphasised that she had noticed a change in students’ attitudes to mathematics. TS2 viewed this change in terms of students’ appreciation of and interest in mathematics. The change in attitudes was a result of students having been able to understand mathematics and its connections to real life.

I think I would just look at what we have experienced. That approach has changed the attitudes of the students. When we use everyday examples, they seem to visualise the whole thing, to connect [with] the real life. They look at it as not just learning [school] maths, but learning maths which is applicable outside [school]. It's part of us. So that helped them to understand what you would bring across. At least they found the lessons interesting because they would see its applicability. If you look at the attitudes towards the subject, they seem to find it interesting, because they appreciated how it’s applicable. The approach has shown that at least they appreciate the subject, the application of the subject and that changed their attitudes. (TS2, Final Interview, 10/9/97)

TS2 felt that her students now saw school mathematics as having connections with their lives outside school rather than being limited to what they were learning in school. However, TS2 regarded it as important to consider the effects
of the intervention on the examination and stressed the need to find out if the
students' performance in the examinations would improve.

We will be able to see the effect on their performance when they write
the exams... . We have to look at it both ways. (TS2, Final Interview,
10/9/97)

In addition, TS2 doubted whether the change in students' attitudes to
mathematics was genuine, since, as can be seen below, TS2 claimed that students
may have felt the need to show interest in the research since they were being
observed.

WM: So in terms of what you think students have gained, that would
be what?

TS2: At the moment I am able to assess their attitudes towards the
[subject]. But I am not able to assess whether it [makes] them
understand... . From my observations of the class, I would
expect that they would change, because I observed that they
used to find the lesson interesting... . But I find that performance
was important because... they [students] knew that they were
[involving in] research, so they showed interest. They knew you
were coming there because you were doing a research with them.
So they were enthusiastic because of the research, maybe not the
subject because they were doing a research. That's why I have to
look at the effect in terms of their performance. (TS2, Final
Interview, 10/9/97)

As can be seen from the above remarks, TS2 felt that a change in attitudes to
mathematics was not worthwhile on its own. An analysis of students’
performance in their final mathematics examinations was also important.

Students getting a real picture of mathematics

TS4 stated that the use of everyday examples enabled students to relate
mathematics to everyday-life experiences. TS4 stressed that, although the
students would not be able to see the occurrence of the events, the important
issue for her was that students were able to build a visual image, a context that
made the topic related to some occurrences in the everyday world.

TS4: The use of everyday examples gives students a real picture, a
real picture of the information that they are getting.

WM: What do you mean by a real picture there?

TS4: The real picture is that when they have the information, they
take it as something which is happening and they are seeing it
happening and it is true. That is what I mean by a real picture.

In order to illustrate what she meant by a "real picture", TS4 recalled a lesson
which involved the application of the Cosine Rule. TS4 saw that the application
helped students to appreciate the use of the Cosine Rule, a topic which students
found difficult to understand.

WM: Do you have any specific examples of how this approach
worked in practice?
TS4: Yes. An example is on the topic of bearing. We had an example of [an application of] bearing — that is, an aeroplane is leaving Chileka Airport for Lilongwe and from Lilongwe it flies to Kenya International Airport. Now what is the bearing of Kenya from Chileka? When we did this practical problem students had in mind that this is what is happening. From Chileka we go to Lilongwe; from Lilongwe we go to Kenya; and from Kenya, it should be back to Chileka. Then what will be the bearing of Kenya from Chileka?

WM: They could see the picture, but they couldn’t see the airport.

TS4: They couldn’t see the airport but they could see the picture. Of course some of the examples that we will be talking about will not be within close proximity. There are places where we can’t reach. So you have to give them an everyday example which will give them a true picture.

WM: So what would be the main thing there that would make them to really see the real picture? What would be the main thing?

TS4: The main thing is that they have the picture so that next time when they come to that thing they should say that, “Oh, this is what she was saying”... The main thing was involvement of themselves. We involved the students themselves to do that. They will have that picture that I did this on that particular day... They would take that individual as an aeroplane. (TS4, Final Interview, 8/9/97)

Although the activity described in the above remarks was not about a real event, since it did not reflect actual events at the time of the lesson, it nevertheless provided a context for the lesson and demonstrated an application of the Cosine Rule. By using the terms “real” or “true” picture, TS4 felt that the use of everyday examples gave students meaningful representations of real-life situations in which mathematical ideas could be applied.

In their comments about the lesson, some Form 4 students found learning mathematics in this way more practical in addition to enabling them to know more about mathematics. The following comments illustrate this.

The manner in which maths is [being] taught now is quite successful compared to the latter style. A lot of maths is done practically rather than theoretically, e.g. when we were learning the “Cosine Rule” the teacher [related] it to [pilots] who use maths to [indicate] directions and calculate distances. Learning is now successful. (S4LED004)

It is beneficial to me because it helps me to know more about maths like activities done at the hall about calculating [bearings] and distances by using cosine rule. (S4LED072)

**Students’ active participation in mathematics lessons**

TS4 claimed that students actively participated in the lesson. This is because she observed, firstly, that relating mathematics topics to everyday experiences stimulated students to talk more in the classroom and to contribute their own everyday knowledge of mathematics. Secondly, because of being given more
examples (everyday as well as content), students became more familiar with the mathematical content. This made them do more exercises than before.

WM: From your observations when you were using these everyday examples, what is the main thing that students have benefited?

TS4: When I started using everyday examples, I saw changes in the students. Those inactive ones were active. What I mean by inactive [is that] they were not participating. When it came to use of everyday examples, they were taking part, they were participating fully. So they were active. And even if we came to chatting and we were trying to explain, they were able to do that. When it came to writing, they were able to write part of the information. But before [that, they] were unable to write anything. (TS4, Final Interview, 8/9/97)

As might be expected, TS4 stressed the importance of looking at students' performance in the examination. This is because, although some students gained knowledge of mathematics and were able to do exercises, TS4 strongly doubted whether they would pass the examination. However, TS4's recognition that the use of everyday experiences was valuable for those students whom she classified as "disabled" in mathematics, is of importance here.

WM: So if you had to describe the most important changes for the students, [they] would be what? Participation?

TS4: Participation, yes. That means they are able to get the information even if academically they will fail but when they go out, they will use that knowledge from here.

WM: So the thing that this method changes, you wouldn't really say [it's] performance.

TS4: Well, we look for performance.... Because some of them are anyway disabled but ... They are not able. They are disabled in mathematics. So I can say it will be difficult for them to improve. When I say improve I mean to pass.... They are saying things have changed. That means they understood the information but for them to use that and pass the examination, it's difficult.... They will use [those] real life experiences. But when it comes to exams they say for me to get 40% and get an 8 [Pass], it will be difficult. (TS4, Final Interview, 8/9/97, emphasis added)

### 6.3.4 Emerging issues

In this section, I describe the major issues that arose from the analysis of interviews and notes of discussion meetings with TD2, TS2 and TS4. The issues were: time, assessment, role of the textbook, and the role of everyday experiences. Although the issues are interrelated, I have described them separately in order to emphasise their significance for the practices of mathematics teaching as shown in the above analysis. Additionally, these seem to be the major aspects that need to be addressed in discussing mathematics teaching and learning conditions in Malawi.
6.3.4.1 Time

All three teachers considered time an important resource in their teaching practice. There were different reasons given for this. Firstly, due to the school timetable at the DEC, TD2 had very limited time within which to effectively teach mathematics. He had only five forty-minute periods a week for each of his classes which consisted of nearly 160 students each. As a temporal remedy to the shortage of time, TD2 introduced extra lessons in the morning hours. Consequently, his students felt they had more time to learn, cover more content and practise mathematics problems.

The shortage of time also constrained the way TD2 thought about his teaching. In particular, when planning lessons, TD2 paid much attention to structuring his lessons within the limits of the school timetable. Ultimately, his teaching principle became one of “following the timetable” and teaching within the time boundaries of his institution. In his terms, acting contrary to the schedule risked TD2 being called a better teacher than the others, a position he felt reluctant to assume.

For both TS2 and TS4, time was also an important aspect in terms of their planning and thinking about teaching mathematics. TS2 emphasised that she had to finish the syllabus because she did not want to spend too much time covering mathematics topics: “I had to finish because I didn’t want to cover the same things for so many days” (TS2, Final Interview, 10/9/97). TS4 stressed the importance of planning lessons within the specifications of the lesson timetable.

You look at the [amount of] time that you have. Let’s say you have 40 minutes.... How much time am I having and how much time will this topic require since we have 40 minutes? Am I going to cover the whole topic in 40 minutes? .... When I am planning, time is the most important thing. Because whatever you have planned should be in line with the time. You shouldn’t overplan, you shouldn’t underplan. (TS4, Final Interview, 8/9/97)

Institutional allocations of time constrained the teachers in their teaching practices. The time factor seems to have been more crucial for TS4 since, in her opinion, she had to train students to be fast when doing mathematics as they were preparing for an examination which allowed them limited time.

6.3.4.2 Assessment

Assessment was a key aspect of the teachers’ thinking about mathematics teaching. For TD2 and TS4, students’ performance in the examination was a key factor to consider. In the final interviews, TD2 repeatedly noted: “How can I teach them so that students should pass their examination?” TS4 noted:
We have a limitation due to the examination. We are after that goal... I want to cover the topics... for examinations' sake". (Notes of Meeting 8, TS2 & TS4, 24/6/97)

Institutional conditions strongly influenced TD2 and TS4 to consider the examination in their teaching plans. The DEC Principal put pressure on TD2 to focus on the examination — to make sure that many students passed the final examination. For TS4, her awareness of the examination-oriented style of mathematics teaching in Malawi, and mastery of the examination system itself, seems to have forced her to focus on the examination in her practice. Although TS4 recognised the limitations of teaching for the examination, she still considered it important to do so since she felt that the examination motivated students and was a critical measure of students' success in schooling.

Mathematics assessment should be there because if the subject is not assessed or examined, I think the subject will not be considered as one of the most important part... Assessment is a gateway to success, because if you are not examined, I don't think you can bother yourself reading or practising that subject. So I think assessment itself motivates the students. It makes them to practice much, and practise not just one but several topics, that is why I said it is a gateway to success. (Notes of Meeting 8, TS2 & TS4, 24/6/97)

TS4's remarks are concurrent with the recommendations of the Report of the Malawi Secondary School Curriculum Review Symposium which stated that students need to be assessed on a “continuous” basis since “this [would] make them work very hard throughout the year as they [would] feel that they are being assessed all along” (Ministry of Education & Malawi Institute of Education, 1995, p. 12). On the other hand, TS2's perceived the role of the examination differently. While she stated that she had not yet mastered the assessment system, she believed that the examination should not drive the teaching process. She appeared to view teaching as a flexible activity which allowed the teacher's autonomy to choose to reflect and question the curriculum. She had a disposition to disagree with established teaching practices, for example, teaching for the examination.

6.3.4.3 Role of the textbook

All three teachers considered mathematics textbooks an important resource for teaching. The availability of mathematics textbooks was particularly important for TD2. This is because he did not have adequate professional training to enable him to teach at the DEC level. Therefore, the textbook offered immediate support for his teaching. The manner in which the DEC Principal introduced TD2 to teach mathematics at the DEC illustrates this point.

I was just given a mathematics [booklet] ... [The Principal] just said "Here is your [booklet]. You will be teaching mathematics". (TD2, Final Interview, 5/9/97)
It is quite evident that the education system expected TD2 to teach by the textbook. This was also expected since the Malawi Distance Education policy required students to study the mathematics booklets and seek the teacher's assistance when faced with a problem. However, given the scarcity of student booklets, it was tempting for TD2 to "lecture". TD2 had to follow booklets because they specified the "objectives" for covering each topic.

Similarly, TS2 found the mathematics textbook a guide that made her aware of what the education system expected students to learn. Although she followed the textbook in her teaching practice, TS2 was reflective about its value especially when assigning mathematics exercises to students. She considered doing mathematics as a "problem-solving" rather than "procedural" activity.

For TS4, the textbook was a main resource particularly for her teaching. She did not expect students to use the textbook in the classroom because she felt that allowing them to use it would distract students' attention from her presentation.

6.3.4.4 The use of everyday experiences

All three teachers made reference to the use of everyday experiences when they described the effects of the research intervention on their teaching practices. However, this was mostly the case for TS2 and TS4, who explicitly stated that they found the use of everyday experiences beneficial in terms of having enabled students to change their views about mathematics. For TS2, the use of everyday experiences made her students realise that mathematics was "part of them". Rather than viewing mathematics as something that is done in school only, TS2 claimed that her students saw that mathematics was "applicable" in everyday life. The approach enabled students to "visualise" and connect mathematics with real life. It made students realise that they were learning about a subject which shaped their everyday lives outside school.

For TS4, the use of everyday experience enabled her students to get a "real picture" of mathematics. This meant that students got a mental image of the connections between school mathematics and everyday life.

On the other hand, TD2 made very little reference to the use of everyday experience when he described the effects of the research intervention on his practice. The only link he made was in terms of the constraints that the teaching activities (based on the use of everyday experiences) posed to his practice. This is evident from the following remark:

The activities are helpful only that there are number of problems like time. These activities need more time... [Students] also say that, concerning the activities, they are more helpful but [they] need time as I said already and they were saying that this should be for Forms 1
and 3, because they will have enough time to practise... But not Form 2s because they are expecting to have examinations. So if they delay with some activities, they will be behind the syllabus... They are rushing. They are working against time. (Notes of Meeting 12, TD2, 30/7/97)

Although, TS2 and TS4 made more explicit reference to the use of everyday experiences than TD2, it needs to be noted here that all the three teachers operated under similar teaching conditions which required them to focus more on what was expected of their role — that is, to cover the content so that students could succeed in their examinations. There was little indication in teachers’ responses that they expected mathematics teaching to involve genuine inquiry strategies and to view the mathematics classroom as a community of inquirers — that is, a community of people who needed to learn more about mathematics and question the usefulness of school mathematics to their everyday lives.
6.4 Analysis of the final student questionnaire

Students' responses to the final student questionnaire were analysed in the same way as those in the first. Each completed final questionnaire (see, for example, Appendix 22) was given an identifying code as described at the beginning of Section 6.1. For example, the code “S4QB001” was used to identify a final questionnaire (QB) completed by a Form 4 student at the SEC (S4). Keywords and detailed comments from students' responses to the questionnaire were then entered in a computer file. Printouts of the data from this file were made. The analysis then proceeded through a process of reading and making commentaries on the data with the aim of identifying common themes or categories among responses. During this process, some of the responses that served as useful information that would enhance a discussion of students' views of mathematics and issues related to change in mathematics teaching were highlighted and compiled in separate files for easy access.

In order to provide a profile of the main issues from students' responses to the final questionnaire, percentages of students whose responses were grouped in each category were calculated for each question. These percentages are shown in Appendix 23. Graphs displaying the distribution of categories of responses were then prepared. Information from these graphs facilitated the comparison of students' responses to similar questions (for example, Questions 1 and 2 in both questionnaires) and identification of patterns in students' responses to Questions 3, 4 and 5 in the final questionnaire.

6.4.1 Results from the final student questionnaire

The results from the final student questionnaire are presented in a similar way as that described in Section 6.1.1 for the first questionnaire. As before, distributions of students' responses to the questions are presented with the aim of providing a profile of issues emphasised by students. In addition, since Questions 1 and 2 in both questionnaires were similar, students' responses to these questions are compared with the aim of determining whether there was any change in the pattern of responses identified in the first questionnaire.

Due to conditions in which the final student questionnaire was administered as described in Section 5.3.1, questionnaire return rates decreased dramatically for the Form 2 students at the DEC and the Form 4 students at the SEC. Out of a total of 329 Form 2 students at the DEC, only 81 returned completed final questionnaires. Only 79 completed final questionnaires were received from a total of 158 Form 4 students at the SEC. However, the number of Form 2 students at
the SEC who completed the questionnaires increased from 54 in the first to 152 in the final, from a total of 189 students. Consequently, the analysis of the final student questionnaire suffered from this disparity in questionnaire return rates. However, the aim of the analysis was to determine patterns in the responses from students as a group rather than perform formal statistical tests on the results.

6.4.1.1 Students’ views of mathematics

Question 1 in the final student questionnaire was as follows:

A Which of the following is closest to how you feel about mathematics now:
(a) very interesting (b) interesting (c) boring (d) very boring.

B Give reasons for your choice.

Figure 6.9 below shows the distribution of responses to this question.

The majority of students, irrespective of grade level and sample size, claim to find mathematics interesting or very interesting. However, slightly fewer Form 4 students than Form 2 students (in both schools) found mathematics very interesting (less than 30% in both the first and final questionnaires). In addition, Figure 6.9 shows that while there was a drop in the percentage of Form 2 students who did not find mathematics interesting (that is, a drop in the percentage of those who chose boring or very boring), the proportion of Form 4 students who did not find mathematics interesting increased.

As in the first questionnaire, students’ responses to Question 1A above suggest that there were essentially two groups of students in terms of how they viewed mathematics, that is, those who found it interesting and those who did not.

6.4.1.2 Reasons for finding mathematics interesting

Question 1B in the final questionnaire required students to give reasons why they found mathematics interesting or very interesting. Students’ responses to this question were analysed in the same way as in the first student questionnaire. However, in addition, a comparison was made between responses to Question 1B in both questionnaires. Figure 6.10 after the next page shows the distribution of students’ responses to this question.

The distribution of responses displayed in Figure 6.10 shows that in the final questionnaire, success, good teaching, and utility of mathematics are the main reasons why students found mathematics interesting.
For all three groups of students, the level of emphasis on success and good teaching was higher in the final questionnaire than in the first. As was found in the analysis of the responses to the first student questionnaire, there is again very little emphasis on students finding mathematics interesting because it increases their knowledge of it. In addition, very few students enjoy doing mathematics, nor do they find mathematics interesting because of its nature.
Figure 6.10: Reasons given for finding mathematics interesting (Q1B)
6.4.1.3 Reasons for not finding mathematics interesting

As previously mentioned, the percentage of Form 2 students (in both schools) who did not find mathematics interesting decreased while that of Form 4 students increased (see Figure 6.9). Figure 6.11 below shows the distribution of categories of reasons why students did not find mathematics interesting, that is, why they chose boring or very boring in Question 1A of the first and final questionnaires.

Figure 6.11 shows that, in both the first and final questionnaires, lack of success and poor teaching are the main reasons students gave for not finding mathematics interesting. In the final questionnaire, no student associated their lack of interest in mathematics with the nature of mathematics or limited resources such as teachers and books.

On the whole, information from Figure 6.11 suggests that lack of success is the main reason given by all three groups of students for not finding mathematics interesting. The percentage of Form 4 students in this category is the highest.

6.4.1.4 The importance of learning mathematics

In Question 2 of both the first and final questionnaires, students were asked the following:

Do you think learning mathematics is important? Please, give reasons for your answer.

Figure 6.12 after the next page shows the distribution of students' responses to this question.

The distribution of responses shown in Figure 6.12 shows that learning mathematics is largely seen as important. As in the first questionnaire, the majority of students still see mathematics as important for utility purposes, that is, it enables students to get a job, run a business or engage in various work-related activities in their everyday life. In addition, there is still little emphasis on learning mathematics for its own sake, that is, to gain knowledge or enable students to become better (mathematical) thinkers. As in the first questionnaire, very few students see mathematics as important for use in other subjects. The Form 2 students at the DEC associate learning mathematics much less with enabling them to get a job or gain access to further education than the students at the SEC.
Figure 6.11: Reasons given for not finding mathematics interesting (Q1B)
Figure 6.12: Reasons given for the importance of learning mathematics (Q2)
6.4.1.5 How students felt about learning mathematics

Question 3 in the final questionnaire was as follows:

*How do you feel about how you have been learning mathematics this year? Explain.*

By asking this question, I intended to collect some information about whether students felt there had been any change in their learning over the period of this research in their classrooms. Due to its open-ended nature, this question yielded various types of responses, such as those which indicated that students had gained some mathematical knowledge, enjoyed the learning methods used, had more learning resources, experienced more success or felt that there was no change in their learning. Figure 6.13 below shows the distribution of students' responses to this question.

Figure 6.13 shows that there was more emphasis placed on feeling successful (SU and PS) by Form 2 students in both schools than by Form 4 students, who felt less successful and saw very little change in their learning. However, it is remarkable that the Form 4 students at the SEC found mathematics more interesting.

For all three groups of students, there is emphasis on having gained a lot of knowledge. Students stated that they had learned a lot, known different ways of solving mathematics problems, or just learned things they did not know before.

- I can say this year we have learnt a lot. We have learnt some kind of problems in maths we have never met. (S2QB143)
- [Learning maths] has pulled me to somewhere because I have come across thing[s] which I never came across. I was just seeing other thing[s] without knowing the use of it. (S2QB062)
- Learning maths this year was successful because I have known much and I am in a position to solve many problems. As a school leaver I will go to the world with much materials .... I am now in the state of knowing much from our teacher and I am always glad with this. (S4QB074)

There was particular emphasis on having learned mathematics content and gained knowledge which was useful for their examinations.

- I feel better because I understand how to solve triangles and I hope during the examinations I will do better. (D2QB077)
- This year learning maths was nice because I've [known] more important things like finding unknown letters, expansion, factorising that can appear during examinations. (S2QB096)

Although some students indicated that they had understood mathematics better, very few explained why.
Figure 6.13: How students felt about learning mathematics this year (Q3)
Some said they understood better "because of the activities which we were doing during classes" (S2QB120), or "[lessons] had vivid examples whereby one could understand easily" (S4QB032). Others just said: "this year maths is well understood" or "maths is better understood".

Very few responses from the DEC students (see Figure 6.11) indicated that their understanding of mathematics had improved. For the Form 2 students at the DEC, and much less for the others, it was important to have more teachers and more time to learn. This can be seen from the following comments.

There is improvement, having two teachers in class of maths now. There must be improvement because we are learning from two teachers all with experience on work. And [the] introduction of morning-hour lessons has made us to go far. (D2QB074)

I am feeling well because last year we had only one teacher and he hadn't anybody to help him when he was lazy. And if one teacher fail[ed] to complete the sum another one help[ed] him. You were helping each other. (D2QB003)

There was some emphasis, but not much, on having learned mathematics more practically rather than by rote.

There is a slight change since sometimes we were learning as part of practical [work] which made us not to forget easily. (S4QB073)

There is a change in how we learn maths because when we learn you give us examples of the things which we used in our everyday life. (D2QB060)

In summary, there is emphasis on students feeling more successful and having gained more knowledge. The Form 4 students at the SEC felt little change in their learning, although they found mathematics more interesting. The Form 2 students at the DEC felt they had more teachers and learning time.

6.4.1.6 Aspects students liked most in learning mathematics

Question 4 in the final questionnaire asked students to state aspects they liked most in their learning of mathematics during the year. An analysis of students' responses to this question produced fourteen categories most of which were viewed as belonging to three broad themes of mathematics content, the teaching and learning process, and resources. Figure 6.14 below shows the distribution of students' responses to this question.

All three groups of students, particularly those in Form 2, placed most emphasis on liking particular topics they had been learning. Students' liking of particular topics was associated with their having known more about the topics or being
**Figure 6.14:** Aspects students liked most in learning mathematics (Q4)
more successful at them. The following comments illustrate this.

There is something which made me happy and [I] liked that topic very much. The name of the topic is simultaneous equations. This topic was very strange to me but this time it is not strange to me and I wish I could learn again this topic [of] simultaneous equations. (S2QB001)

I liked Algebra and Geometry [more] than Arithmetic. You don’t need more information in solving problems [in Algebra and Geometry]. In Geometry most of the times the answers are there. In Arithmetic there are a lot of conventions. (S4QB049)

The Form 4 students at the SEC commented more about the learning process than the Form 2 students in both schools. Instead of thinking mostly in terms of liking particular mathematics content, the Form 4 students commented more about the teaching and learning methods used during lessons, for example, those which related mathematics topics with everyday life. This can be seen from the following remarks.

I liked the way our teacher introduced new topics to us especially by relating to everyday life because not most of the students knew the importance of some parts of maths ... (S4QB004)

I like the approach of the maths teacher. She is more approachable. The way the teacher introduced the topics aroused my interest to fully participate in maths classes. (S4QB003)

The giving of chance to students to explain some of the problems during classes encouraged me. The teachers' arguments were well represented with reality examples. We had nice classes where we were free to do whatever we felt like doing. (S4QB013)

Comments from some Form 2 students at the SEC indicate that they had a more limited view of learning. They liked the teacher’s kindness, her ability to answer all questions and give exercises which were similar to examples given in class.

I am happy because our teacher started a new method of teaching us. She is always kind when teaching. I like the way she does nowadays I think if she started it before this research, all of us would be liking maths. (S2QB124)

Mostly I was interested with our teacher... And I was happy [because] everything I asked [her], [she] never failed to answer. If it was a problem, it was in my head. (S2QB062)

We were given a lot of examples and the exercises which we have been doing were not irrelevant to the examples... (S2QB083)

As shown in Figure 6.14, the Form 2 students at the DEC commented more on the availability of resources for their learning, that is, they felt they had more learning materials and time than previously.

6.4.1.7 Aspects students liked least in learning mathematics

Question 5 in the final questionnaire asked students to state any aspects which they liked least in their learning of mathematics during the year. As in Question 4
Figure 6.15: Aspects students liked least in learning mathematics (Q5)
discussed above, the analysis of students' responses to Question 5 produced a wide range of categories most of which belonged to three broad themes of mathematics content, the teaching and learning process, and resources.

Figure 6.15 above shows the distribution of students' responses to this question.

As displayed in Figure 6.15, students placed most emphasis on not liking particular topics they had learned. These were mostly topics they had found difficult. As Figure 6.15 shows, the level of emphasis placed on other aspects was small and varied among the three groups of students. For example, the Form 2 students at the DEC placed little emphasis on the process of learning except on aspects to do with silence in the classroom and insufficient learning materials. As can be seen in the following comments, these aspects were mostly related to their general context of learning.

Many students were making noise, so most of the things were not entering in the head. (D2QB036)

I was not happy because you did not give books from which to solve maths when we are at home. (D2QB063)

We did not have enough learning materials eg blackboard. We were learning while sitting on the floor. (D2QB067)

The Form 4 students stated that they had too much mathematics content to be covered. They did not like the slow teaching pace.

I feel that we had only one problem whereby there was need to be fast in teaching for we were running short of time. But all the same we managed to finish up the syllabus. (S4QB002)

Your introduction to a new topic is a little bit very slow. I was not impressed in other times but it's fine. (S4QB007)

As shown in Figure 6.15, some Form 2 and Form 4 students at the SEC did not like the style of assessment used in their learning. Responses from this group of students highlighted that they did not like being given difficult mathematics problems, especially when they had not done any examples similar to these problems.

I least liked the tendency of giving simple examples and giving difficult questions for an assignment. (S4QB078)

According to our little knowledge of solving sums, it is not good to give us an example different from the real exercise. (S2QB131)

Giving us examples with parallel exercises: this is the main problem I am facing. The way the example has been given is not similar to the way we are given the exercise. (S2QB097)

A small proportion of Form 2 students did not like being asked a lot of questions or asked to participate in class discussions.

You were asking too much questions which made some students not to answer the questions during the learning period. (S2QB093)
I least liked teaching by firing students with questions while the students are just learning that topic. \(\text{(D2QB013)}\)

I least liked [when you were] mentioning someone before raising his arm because you confuse him on how he was solving the sum. \(\text{(S2QB005)}\)

The above comments suggest that some students felt less comfortable about being asked questions which were intended to clarify their ideas and understanding about mathematics.

As shown in Figure 6.15, some students emphasised that they disliked nothing about their learning of mathematics during the year. As the following remark show, these students belonged to a group which felt successful and generally satisfied with their learning.

Everything makes me to be happy, that is why I pass maths. I always put my heart in science subjects in order to be a scientist in future. \(\text{(S2QB101)}\)

However, it may also mean that some of these students do not see any need to question the way they are learning mathematics. The following remarks illustrate this.

Nothing was bad to me, everything was good. The teaching techniques were good also. \(\text{(S2QB046)}\)

There isn’t anything which [I liked] least because everybody was patient, listen[ing] to the teacher and do[ing] everything that the teacher [asked] us to do. \(\text{(D2QB014)}\)

### 6.4.2 Emerging issues

#### 6.4.2.1 A focus on success and utility

Students’ responses to the final questionnaire were similar to those in the first. As in the first questionnaire, the analysis of the final student questionnaire shows that most students claim to find mathematics interesting. The reasons are again mainly concerned with success and the utility of mathematics. Additionally, emphasis on success dominated students’ comments about how they felt in learning mathematics during the year, particularly the Form 2 students from both schools. As in the first questionnaire, these students consider mathematics as a performance subject and one that is universally important to learn.

In contrast with the others, for Form 4 students at the SEC, lack of success remained the dominant reason why they did not find mathematics interesting (see Figure 6.11). In addition, as can be seen in Figure 6.13, the Form 4 students felt less successful and felt there was not much change in their learning. It seems that the Form 4 students represented a group which felt more negatively about mathematics than the others. For them, they were learning mathematics for the
sake of fulfilling school requirements since mathematics was a compulsory subject. Hence it was less possible for the Form 4 students than the others to experience change in learning.

6.4.2.2 Focus on content

Students placed strong emphasis on liking or not liking specific topics (see Figures 6.14 and 6.15). This suggests that students were mostly interested in mastering the mathematics content so that they could be successful at it. As one student commented, they wanted teaching to focus on areas they considered important. They had little interest in detailed explanations.

One thing which I know is that your teaching was long, full [of] explanation. When you are teaching, try [to] explain only the important points [for] us to take. (D2QB073)

The above remark indicates that for some students, knowing the mathematics content was more important than knowing about the process of knowing it.

6.4.2.3 Form of assessment

Some students did not like the style of assessment used in mathematics lessons. They wanted exercises to be similar to examples given in class. These students did not seem to like being challenged to apply their knowledge in unfamiliar situations. They preferred to learn by examples, and possibly resisted taking risks in their learning. This represents a view of learning as accumulating mathematical skills and procedures which need to be memorised and recalled when solving routine mathematics problems. Any problems which were not similar to the examples given in class were considered to be aimed at "teasing their brains" (SAQB009) rather than representing an opportunity for students to test their understanding of mathematical concepts.

The analysis of the final student questionnaire shows that students were interested in mathematics more particularly for success in learning and utility of mathematics than for aspects related to the discipline of mathematics per se.
6.5 Students’ examination results

As described in Chapter 5, the Form 2 and Form 4 students involved in this study wrote national examinations in mathematics and other subjects. The examinations were externally set and were based on the material students were expected to cover in their syllabi. Examinations in all subjects at the Form 2 level were compulsory. At the Form 4 level, only the examinations in mathematics and English were compulsory. It needs to be noted here that at both levels, all students needed to pass English examinations in order to be awarded certificates. Although mathematics was compulsory, it was not a requirement for students to pass it in order to be awarded certificates.

At the end of the study in the two schools, I collected students’ examination results for mathematics as well as other subjects. This study had a short-time frame. Therefore, I did not expect the intervention to result in any major changes in students’ performance in the examinations. However, this is not to ignore the possibility of the intervention having some effects on students’ performance, particularly given that some students, especially at the DEC, felt they had more time to learn mathematics than previously. Nevertheless, it may not be possible to directly associate any change in performance with the research intervention. However, at the very least, the aim of this aspect of the study was to establish that students’ performance in the examinations had not deteriorated for reasons pertaining to their participation in the research.

This section describes the analysis of the students’ examination results in the following way. First, it compares the results of the 1997 students in this study with those from similar classes in the same school in 1996. Secondly, it describes teachers’ comments on the examination results to find out whether the students had performed according to the teachers’ expectations, and whether the students in the two schools performed better or worse than students in other schools nationally.

The analysis in this section consists of the following aspects:

- an analysis of students’ examination results in mathematics for the students involved in this study in 1997 and the corresponding group for 1996. This is done both at the school level and nationally;

- a comparison of students’ examination results in mathematics with those in other subjects for students involved in this study (1997) and the corresponding group in 1996; and
• an analysis of teachers’ (that is, TD2, TS2 and TS4) comments on the examinations results.

The analysis carried out on the examination results was done descriptively. The main interest was to describe the differences, if any, in students’ performance between 1996 and 1997, rather than to perform formal statistical tests on the examination results.

### 6.5.1 Description of the examination results data and analysis

The data for the 1996 and 1997 examination results consisted of the following:

• a list of all Form 2 students at the DEC and the SEC, with grades indicating whether a particular student had passed a subject (that is, obtained either grade A, B, C, or D) or failed it (that is, obtained grade F);

• a list of all Form 4 students with grades indicating whether they had passed a subject (that is obtained either grade 1, 2, ..., or 8) or failed it (that is, obtained grade 9);

• average percentage pass in mathematics nationally; and

• teachers’ comments on the examination results. These consisted of short memos from TD2, TS2 and TS4 with comments on whether students had performed according to teachers’ expectations, and whether their students performed better or worse than students in other schools nationally.

The analysis of students’ examination results proceeded in three stages. In the first stage, my main aim was to obtain a distribution of students’ grades in mathematics only. In order to do this, I counted the number of students who obtained a particular grade in mathematics. For example, no student obtained either grade A or B in the 1997 mathematics examination at the DEC. There were only 7 students who obtained grade C, while the numbers of students who obtained grades D and F were 78 and 123, respectively. Table 6.8 on the next page shows the distribution of grades in mathematics for Form 2 DEC students.

Similarly, I prepared distributions of grades for Form 2 and Form 4 students at the SEC. These distributions are presented in later sections of this Chapter.

I then calculated percentages of the number of students who passed mathematics, that is, those who obtained grades A to D for the Form 2 students, and those who obtained grades 1 to 8 for the Form 4 students. For example, from Figure 6.8 above, there were 85 out of 234 Form 2 DEC students who passed mathematics in 1996. This represented a percentage pass of 36%. In 1997, 46% — that is, 152 out of 329 students, passed mathematics. Similarly, I calculated
the percentage passes in mathematics for the Form 2 and Form 4 students at the SEC.

Table 6.8

Distribution of Mathematics Grades for Form 2 DEC Students in 1996 and 1997

<table>
<thead>
<tr>
<th>Grade</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>F</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of students in 1996</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>78</td>
<td>149</td>
<td>234</td>
</tr>
<tr>
<td>No. of students in 1997</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>138</td>
<td>177</td>
<td>329</td>
</tr>
</tbody>
</table>

Note: Grade A = Excellent, B = Very Good, C = Good, D = Average, F = Fail

I then compared the percentage passes in mathematics for the three groups of students with the national averages for both 1996 and 1997. These percentages are shown in Table 6.9 below.

Table 6.9

Students' Examination Results in Mathematics and Corresponding National Averages for 1996 and 1997

<table>
<thead>
<tr>
<th>Class</th>
<th>Year</th>
<th>Total No. of Students</th>
<th>No. Passed Maths</th>
<th>% Passed Maths</th>
<th>National Average: maths (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form 2 DEC</td>
<td>1996</td>
<td>234</td>
<td>85</td>
<td>36</td>
<td>76*</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>329</td>
<td>151</td>
<td>46</td>
<td>60*</td>
</tr>
<tr>
<td>Form 2 SEC</td>
<td>1996</td>
<td>163</td>
<td>109</td>
<td>67</td>
<td>80#</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>189</td>
<td>177</td>
<td>94</td>
<td>87#</td>
</tr>
<tr>
<td>Form 4 SEC</td>
<td>1996</td>
<td>126</td>
<td>76</td>
<td>60</td>
<td>48*</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>158</td>
<td>46</td>
<td>29</td>
<td>35*</td>
</tr>
</tbody>
</table>

Note: * indicates Average for Form 2 students in all DEC schools in Malawi
# indicates Average for Form 2 students in all SEC schools in Malawi
* indicates Average for Form 4 students in all SEC schools in Malawi

The second stage in the analysis was to compare students' examination results in mathematics with the results in other subjects. I calculated the percentage of students who passed each subject in both the 1996 and 1997 examinations. For example, there were 215 out of 329 students who passed English in 1997 at the DEC. This represented a percentage pass of 76%. Appendix 24 shows the number of students and percentage passes for each subject for the 1996 and 1997 examinations.
In order to find out whether there were any differences in the results, I entered the percentages shown in Appendix 24 in an excel file. I then prepared graphs indicating the distributions of percentage of students who passed each subject. These graphs enabled me to describe the general trend of performance of students for each subject between the two years. They also enabled me to compare students’ performance in mathematics and that of other subjects.

In order to conclude the second stage of the analysis of examination results, a further analysis was undertaken. This concerned the fact that at the end of the Form 2 and Form 4 level, students were awarded a Junior Certificate or Malawian Certificate of Education, respectively, based on their performance in six subjects, not necessarily including mathematics. As noted earlier, mathematics was one of the compulsory subjects. It is therefore possible that students’ preparation in the examination may have been affected due to being forced to take an examination in a subject they possibly were not good at. The later part of the analysis therefore consisted of a comparison between the percentage of students who passed mathematics and those who were awarded a certificate. This comparison was done at the school level as well as at the national level.

The percentages of students who were awarded certificates in the two schools were collected directly from the schools themselves. However, the national figures were collected from the Malawi National Examinations Board through the teachers involved in the study.

Table 6.10 on the next page shows the percentage of students who passed mathematics and the percentage of students who were awarded certificates at the school and national level.

It needs to be emphasised that the aim of making the above comparison was to ascertain whether the performance in mathematics at the schools involved in the study followed the trend for the school and national average in terms of overall percentage of students who were awarded certificates.

The third stage in the analysis of examination results was to describe teachers’ views about the results. It needs to be noted here that teachers’ comments on the examination results were not detailed since I had very little contact with them after concluding the study in the two schools in Malawi. Similarly, due to communication problems, it was difficult to find out from the students themselves how they felt about the examinations. Nevertheless, the teachers’ comments, which were about an A4-page in length for each teacher, were adequate to allow me to describe how they generally felt about the examination results. In addition, teachers’ comments on the examinations allowed to gain
insights about a number of conditions associated with assessment in the two schools as well as teachers views about ways of improving students' performance in mathematics. Most importantly, through the teachers' comments, I was able to conclude whether they thought students' participation in the research affected their performance in the mathematics examinations.

Table 6.10

Percentages of Students Who Passed Mathematics and Those Awarded Certificates

<table>
<thead>
<tr>
<th>Class</th>
<th>Year</th>
<th>Total No. of Students</th>
<th>% passed Maths</th>
<th>% Awarded Certificate (School level)</th>
<th>% Awarded Certificate (Nationally)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form 2 DEC</td>
<td>1996</td>
<td>234</td>
<td>36</td>
<td>56</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>329</td>
<td>46</td>
<td>52</td>
<td>76</td>
</tr>
<tr>
<td>Form 2 SEC</td>
<td>1996</td>
<td>163</td>
<td>67</td>
<td>88</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>189</td>
<td>94</td>
<td>97</td>
<td>83</td>
</tr>
<tr>
<td>Form 4 SEC</td>
<td>1996</td>
<td>126</td>
<td>60</td>
<td>50</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>158</td>
<td>29</td>
<td>23</td>
<td>25</td>
</tr>
</tbody>
</table>

6.5.2 Students' examination results in mathematics

In this section, I describe the results of the analysis of the mathematics examination data. The aim is to draw some conclusions about the general trend in students' performance in mathematics and establish whether the results followed the trend at school and national level.

Table 6.11 on the next page shows the percentage of students who passed mathematics and the corresponding school and national averages.

Table 6.11 shows that the percentage of Form 2 students at the DEC who passed mathematics increased from 36% in 1996 to 46% in 1997. Although there was a slight increase in the percentage of students who passed mathematics, the performance of Form 2 students at the DEC remained below the school as well as national DEC average in both years.

The percentage of Form 2 students at the SEC who passed mathematics increased from 67% in 1996 to 94% in 1997. In 1996, the percentage of Form 2 students who passed mathematics was lower than the national average of 88%, while in 1997, it was higher. This suggests that there was an improvement in performance in mathematics for the Form 2 students at the SEC.
Table 6.11
Students’ Examination Results for 1996 and 1997

<table>
<thead>
<tr>
<th>Class</th>
<th>Year</th>
<th>DEC/SEC School Results</th>
<th>National Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total No. of students</td>
<td>No. passed maths</td>
</tr>
<tr>
<td>Form 2 DEC</td>
<td>1996</td>
<td>234</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>329</td>
<td>151</td>
</tr>
<tr>
<td>Form 2 SEC</td>
<td>1996</td>
<td>163</td>
<td>109</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>189</td>
<td>177</td>
</tr>
<tr>
<td>Form 4 SEC</td>
<td>1996</td>
<td>126</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>158</td>
<td>46</td>
</tr>
</tbody>
</table>

On the other hand, the percentage of Form 4 students who passed mathematics at the SEC decreased drastically from 60% in 1996 to 29% in 1997. The performance in mathematics in 1997 was also lower than the national average of 35%. However, a similar pattern was observed when the percentage of Form 4 students who were awarded certificates was compared with the national averages for both 1996 and 1997. As shown in Table 6.11, 50% of the Form 4 students at the SEC were awarded certificates in 1996, while only 23% received certificates in 1997. At the national level, 62% of the students received certificates in 1996. In 1997, the percentage reduced to 25%. Hence for the Form 4 students, it appears that the drop in performance in mathematics reflected the general pattern of performance for the SEC as well as nationally. While this happened, it may not necessarily be correct to associate the overall student poor performance with students’ performance in mathematics. This is because there were a number of students who failed mathematics but who still received certificates. As indicated at the beginning of Section 6.5, although mathematics is compulsory, it is not a requirement that students should pass it in order to be awarded a certificate.

6.5.3 Examination results in mathematics and other subjects

In this section, I compare students’ examination results in mathematics and those for other subjects for all three groups of students. The aim is to establish whether students’ performance in mathematics reflected the general pattern in their performance in other subjects. Although the Form 2 students in both schools wrote the same examinations, the comparison is done separately here in order to emphasise the differences in the learning conditions between the two schools, and
hence the differences in students’ performance. In addition, a description of the teachers’ comments on the examination results is presented.

6.5.3.1 At the DEC: Form 2 Examination results

The Form 2 students at the DEC wrote examinations in ten out of twelve subjects offered at the Junior Certificate level. No student wrote examinations in French and Home Economics because there were no teachers in these subjects.

Figure 6.16 below, prepared from Appendix 24, shows the distribution of the percentage of students who passed each subject in the 1996 and 1997 Junior Certificate Examination at the DEC.

![Bar chart showing percentage of students who passed in different subjects at the DEC in 1996 and 1997]

*Figure 6.16: Percentages of Form 2 students who passed each subject at the DEC*

As shown in Figure 6.16 above, there was a general decrease in the percentage of students who passed each subject in 1997 compared with those in 1996. The decrease occurred in six out of ten subjects. On the other hand, Figure 6.16 shows that mathematics was one of the four subjects in which the percentage pass increased. It is evident, however, that the performance in mathematics was among the poorest of all the subjects at the DEC.

The slight improvement in performance in mathematics as shown above may have been due to many factors apart from teaching quality. For instance, the students involved in 1997 were not the same students who wrote the 1996 examinations. In addition, there were more students in 1997 than in 1996, an increase of nearly 100 students over 1996 (see Table 6.11 above). Nevertheless,
considering that the students wrote the same type of examinations (that is multiple choice), the students' performance in mathematics as indicated above followed the trend.

Although the Form 2 DEC students claimed to have "learned a lot" during the year (see Section 6.4), their gain in knowledge may not have been directly relevant to the requirements of the examinations. In addition, the examinations assessed the material covered over a period of two years. Students' participation in the research for a period of only five months is likely to have made little difference in students' knowledge of the mathematics content.

**TD2's comments on the examination results**

TD2 observed that students showed interest in mathematics during the time of the research. However, he expressed disappointment with students' performance in the 1997 mathematics examination results. He had expected more students to pass the examination. In addition, he had expected some students to achieve better grades in the 1997 than 1996 examination.

> I am expecting to have a number of [students], even though a small number, maybe one of the students, to get an "A" or "B" [grade].
> (TD2, Final Interview, 5/9/97)

Some students also expected to do well in their examinations.

> I think many students at this school will pass maths because the subject has been so good that everyone was able to solve some of the problems. (D2QB045)

As shown in Figure 6.16, students' performance in mathematics was poor. No student obtained grade A or B and most of the students either failed mathematics or obtained grade D (see Figure 6.8 in Section 6.5.1).

For TD2, the poor performance in mathematics was due to a number of conditions mostly beyond his control. These included the type of examination itself; background, motivation and general abilities of students.

**The type of examination**

TD2 expressed dissatisfaction with the multiple choice examination now being used to assess students' mathematics learning. (This was the third year since the introduction of multiple-choice in 1995). He noted the overload in the examination since it contained sixty questions and required students to answer them in 2 hours. This shortage of time encourages students to guess answers to questions rather than solve the problems. It also encourages others to cheat during the examination. Consequently, TD2 did not like the multiple choice examination because he felt that mathematics was more about problem solving.
than guessing. According to TD2, multiple choice examinations promote laziness among students.

I hate this system of multiple choice [exams], especially in mathematics. The subject is not suitable for multiple choice. Mathematics needs solving not guessing. This system tries to encourage students to be lazy. Looking at number of questions in [the] mathematics [exam], [there] seem too [many] questions. Time [available] to solve those questions is not enough. One cannot solve a sum like simultaneous equations within two minutes. [Since they] fail to [catch up] with time, students depend on guess work, [although they] can't guess all the problems right. (TD2, Comments on Examination Results, 1/9/98)

Student educational background and abilities

Regarding students' abilities, TD2 emphasised the following:

Students themselves are very lazy. They don't concentrate their studies. You find some students chatting outside classes while others are learning. When teachers give exercises to students, they don't write. As a result, teachers are unable to evaluate their lessons. Especially in mathematics, it needs a lot of practice. (TD2, Comments on Examination Results, 1/9/98)

TD2 claims that there is a general lack of motivation for DEC students to study, write assignments and practise solving mathematics problems. The policy of distance education expects students to study on their own most of the time. However, TD2's remarks seem to reflect the generally low motivation observed in some students during the research. Some of them often sat and did nothing during lessons. At the same time, this occurred mostly because the students were overwhelmed by the adverse learning conditions at the DEC. As one student noted, it was very difficult for one teacher to mark all students' work due to the large number of students.

Just imagine that if in a class [there] are more than 100 students, and a teacher give[s] an exercise, this openly shows that [the] teacher will fail to mark all the exercises. (D2QA142)

In agreement, TD2 said the following:

We have many students in DEC$s. Class management is very difficult. Just [imagine], last year we had about 300 Form 2 students. Do you think one can manage to mark 280 exercise books everyday? So [the] large number of students has contributed [to] bad results in last year's exams.... This year we have more than 300 students in Form 2 and we are definitely expecting to have bad results. (TD2, Comments on Examination Results, 1/9/98)

Implicit in TD2's comments is the belief that students can perform well in mathematics through practice. In other words, success in mathematics can be achieved through regular practice. This seems to be a prevailing belief in students' views about mathematics as well. When students were asked to suggest ways of changing mathematics in order to make it more interesting for them (see
Section 6.1, most of the students stated that they themselves needed to change. They placed emphasis on practising mathematics problems more regularly.

TD2 did not expect most students to pass since he believed that they did not have the necessary mathematics background. He believed that students were neither adequately prepared to learn effectively at the Junior Certificate level nor competent to sit for examinations. He categorised most students as failures who only got enrolled at the DEC through bribery.

Many students in DECs are trouble makers and failures of the Primary School Leaving Certificate (PSLC). Just imagine how can one teach a failure student, [and how can one expect a student] who failed PSLC to pass JCE (Junior Certificate Examinations)? In fact it could have been better to [follow] the right procedure for enrolling students in DECs. I think bribery in Primary Schools is highly accepted. You find some candidates who failed Standard 8 (PSLC) have got testimonials which indicate that they have passed their PSLC Exams. So it's very difficult for teachers in DECs to verify [them], That's why the DEC teachers have a hard task dealing with these students. (TD2, Comments on Examination Results, 1/9/98)

TD2 did not seem to have attributed the poor performance of students to any factors concerning teaching quality nor the difficulty of the subject as claimed by many students in their responses to the first questionnaire (see Section 6.1). This suggests that for TD2, the poor performance in mathematics was due to factors largely concerned with students' abilities.

In his comments to the examination results, TD2 did not make any explicit remarks that related to the effectiveness of the research intervention. This may suggest that the intervention was possibly not on the list of his priorities as an aspect that needed consideration in order to improve students' performance in the examinations.

6.5.3.2 At the SEC: Form 2 Examination results

The Form students at the SEC wrote examinations in twelve subjects offered at the Junior Certificate level. They wrote the same examinations as those at the DEC.

Figure 6.17 below shows the distribution of the percentages of students who passed each subject in the 1996 and 1997 Junior Certificate Examination at the SEC.

As can be seen from Figure 6.17, there were a general increase in the percentage of students who passed in most subjects in 1997 compared to 1996. This occurred in nine out of twelve subjects. However, the increase was greatest in mathematics. In addition, the percentage of students who passed mathematics changed from being one of the lowest in 1996 to nearly one of the top in 1997.
Figure 6.17: Distribution of percentages of Form 2 students who passed each subject at the SEC

It needs to be noted here that the increase in the percentage of students who passed in 1997 at the SEC was much higher than at the DEC for almost all subjects. This suggests that there were some differences in the students' abilities between the DEC and the SEC. This is clearly the case since most SEC students are selected from the top 10% of the students who pass the Primary School Leaving Certificate examination. It is also because the students at the SEC had access to more resources and had more time to learn than those at the DEC. Consequently, the research intervention may have been more beneficial to the SEC than DEC students since the former were already benefiting from the more adequately resourced conditions in the SEC. The SEC students were also receiving more attention from teachers than at the DEC.

Since the performance in mathematics followed a similar trend to that in other subjects, it is possible to say, at the very least, that students' performance was not disadvantaged by their participation in the research. At the same time, the effect of the research intervention on the examination results cannot be implied directly due to several factors which may have contributed to the increase in the percentage pass in mathematics.
TS2's comments on the examination results

TS2 gave very brief comments on the examination results. However, her comments were useful since they highlighted some of the problems associated with the assessment of mathematics at the Form 2 level.

Table 6.12 below shows the distribution of grades in mathematics for Form 2 students at the SEC.

Table 6.12

Distribution of Grades in Mathematics for Form 2 SEC Students in 1996 and 1997

<table>
<thead>
<tr>
<th>Grade</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>F</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of students in 1996</td>
<td>0</td>
<td>2</td>
<td>38</td>
<td>69</td>
<td>54</td>
<td>163</td>
</tr>
<tr>
<td>No. of students in 1997</td>
<td>1</td>
<td>42</td>
<td>89</td>
<td>45</td>
<td>12</td>
<td>189</td>
</tr>
</tbody>
</table>

Note: Grade A = Excellent, B = Very Good, C = Good, D = Average, F = Fail

Although Table 6.12 above (and Figure 6.17) shows that Form 2 students at the SEC generally performed better in 1997 than in 1996 in mathematics, TS2 did not consider this improvement as genuine. She suspected that students used deceptive strategies to enable them to pass the examinations.

The results were better than the previous year, overall, but a closer look at them revealed some anomalies. There were a number of students who unexpectedly performed very well in the exams. I wouldn’t explain that [as an] improvement but perhaps luck or cheating. When a student who would always fail, but gets a B [in the exam], it does raise suspicion. (TS2, Comments on Examination Results, 13/10/98, emphasis in original)

Of particular importance in the above comments are those concerning the credibility of multiple choice examinations. While there were students who could do well as a result of having understood mathematics, such students may not have done well in the final examinations. On the other hand, students who made little attempt to understand mathematics were possibly rewarded by being successful on the examination. Given the emphasis placed on passing the examination, particularly in mathematics, it is conceivable that such students may have cheated.

Although TS2 dismissed the results as suspicious, she still maintained that the examination played a crucial role in her teaching. She felt it important to teach mathematics so that students become interested in the subject. However, performance in the examination posed a major constraint.

Since at the end of the day the stress is on performance, it seems to me that it is difficult to change students’ general attitude to the subject.
Finding the lessons interesting but failing exams at the end of it would still make some feel that the subject is difficult. (TSZ, Comments on Examination Results, 13/10/98, emphasis in original)

6.5.3.3 At the SEC: Form 4 Examination results

Before describing the differences between students' performance in mathematics and other subjects at the Form 4 level, it is crucial to note the differences in the number of subjects which Form 4 students are allowed to sit for in examinations compared to students at the Form 2 level.

English and mathematics are compulsory subjects at the Form 4 level. In addition, examination regulations require students to sit for a minimum of six subjects in the final examinations (Malawi National Examinations Board, 1989). Hence students in Form 4 are examined in fewer subjects than those in Form 2. However, the content of the examinations is significantly different from that at the Form 2 level. This is for two reasons. Firstly, the examinations at Form 4 cover material taught over a period of four years in the secondary education system in Malawi. Secondly, the main aim of the examination in Form 4 is to select students for further education. Since there are very few places available at the university, the content is generally of such a level that only the most capable students succeed.

Since English and mathematics are compulsory at Form 4, the students only have to choose another four subjects from the Malawi Certificate level. However, many students choose to do more than six subjects. Therefore, while all the 158 Form 4 students in 1997 wrote examinations in English and mathematics, fewer students wrote examinations in other subjects. For example, in French, only 14 out of 158 students wrote the examination. Eleven of these passed, representing a percentage pass of 79%. In commerce, 17 out of 158 students wrote the examination in 1997. Only 3 of these passed, representing a percentage pass of 18%. The number of students and percentage of students who passed each subject is shown in Appendix 24.

Figure 6.18 below shows the distribution of the percentage of Form 4 SEC students who passed each subject in the 1996 and 1997 Malawi Certificate Examinations.
Figure 6.18: Distribution of percentage of Form 4 students who passed each subject at the SEC

Figure 6.18 clearly shows that there was a general decrease in the percentage of students who passed most of the subjects in 1997 compared to 1996. The only exception was in English and Physical Science in which the percentage passes increased slightly. The percentage passes in mathematics, Biology and Commerce, were among the worst. The percentage pass in mathematics was close to the lowest of all the subjects, in both years.

Given the general decline in the performance of students across the subjects, the performance in mathematics was possibly expected. This is evident from the percentage of students who passed mathematics nationally (that is, 35% in 1997), and most crucially, the overall performance nationally, that is, 25%. The performance in mathematics was therefore a result of a number of factors some of them not related to or beyond the research intervention.

TS4's comments on the examination results

TS4’s comments on the examination results were mostly about the type of examination and the abilities of the Form 4 students to pass examinations. According to TS4’s she had expected some students to do well in the mathematics examinations.

The comment I can make on the results for the previous Form 4s is that the results were very poor. The students that I thought [would]
pass mathematics with distinctions didn’t do so. Some of them even failed to get a pass. The pass percentage was very low…. Those who passed were the same ones [who were] doing well in class. The number that passed mathematics wasn’t good even though two students [got] distinctions. (TS4, Comments on Examination Results, 12/9/98)

Table 6.13 below illustrates TS4’s remarks. The range of grades shows that most students obtained grade 9, that is, failed in mathematics. Only 2 of 158 students obtained distinction grades.

Table 6.13

<table>
<thead>
<tr>
<th>Grade</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of students in 1996</td>
<td>0</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>22</td>
<td>37</td>
<td>50</td>
<td>126</td>
</tr>
<tr>
<td>No. of students in 1997</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>12</td>
<td>21</td>
<td>112</td>
<td>158</td>
</tr>
</tbody>
</table>

Note: Grades 1 & 2 are distinctions, Grades 3 to 6 are credit passes; Grades 7 and 8 are passes, and Grade 9 is a fail

Type of examination and student abilities

On the basis of the students’ comments, TS4 concluded that the examination was not difficult. For TS4, the poor performance of students in mathematics had nothing to do with the level of difficulty of the subject but had more to do with students’ abilities, particularly their lack of speed in working with mathematics.

Although the [questions] … were fair enough, most of the students got 9 points…. The papers were not too difficult. Most of the questions were those done in class as practical examples. It was found out from them that they failed due to exam fever and others said they failed because time for writing both papers was not enough at all so they managed to answer few questions whose total marks couldn’t offer them a pass. So most of the students complained about time. (TS4, Comments on Examination Results, 12/9/98)

The above comments emphasise TS4’s view that students failed not due to ineffective teaching, but due to the abilities of the students themselves.

As in the interview, TS4 emphasised the importance of training students to work rapidly and think logically in mathematics. She emphasised these attributes as most lacking in the Form 4 students, and believed that this contributed heavily to their performance in mathematics examinations.

The students that we have nowadays have less ability. Lack of much practice on their own is a contributing factor…. They don’t think fast and write fast logically. This contributes much to the failure of most
students not only from this school but also from other schools within the country. (TS4, Comments on Examination Results, 12/9/98)

TS4 viewed mathematics as a logical subject that requires speed and logic. Her emphasis on students having failed due to lack of practice implies that she believed practising mathematics problems and following the rules of mathematics contribute significantly to students’ success in mathematics.

It needs to be emphasised here that TS4 felt that the poor performance in mathematics was not due to negligence in teaching. She highlighted that she had used the approach of everyday experiences which, according to her, facilitated her teaching efforts and made students grasp ideas fast.

The report from the examiner was that [students in] most schools didn’t perform well in mathematics. Some teachers are doing a commendable job when teaching mathematics, [for example], by using everyday examples, but the problem is with our present students. So it was suggested that parents should also assist by making sure that their children are studying even during holidays. They shouldn’t throw away their books because they are on holiday. Parents must be concerned about the results sent to them... . Most of the students are failing because they are not talked to. The ball is left [to the] teacher only. (TS4, Comments on Examination Results, 12/9/98)

TS4 quoted the report from the Malawi National Examinations Board as stating that the poor performance in students was not due to teaching ineffectiveness but due to cheating, students’ lack of motivation to study and lack of parental guidance to ensure students are practising mathematics during the holidays.

6.5.4 Emerging issues

The analysis of students’ examination results described above resulted in rather inconclusive evidence regarding whether the research activities improved or disadvantaged students’ performance in mathematics examinations. This section, therefore, raises three key issues concerning the performance of students in examinations. These issues concern the poor performance in mathematics examinations, the authenticity of the examinations, and, consequently, the pedagogical tension between teaching and assessment.

6.5.4.1 Poor performance in the mathematics examinations

The analysis of students’ examination results has shown that the performance in mathematics examinations was generally very poor. The Form 2 students at the DEC performed poorly both at the school level and nationally in 1996 and 1997, although there was a small improvement in pass rate in 1997. There was a big decline in the Form 4 students’ results in 1997, nationally. On the other hand,
there was a marked improvement in the performance of the Form 2 students at the SEC.

Although students' performance was shown to be within the expected trend, the poor performance in mathematics at the Form 2 DEC and Form 4 SEC levels raises serious concerns for students' success in mathematics. In addition, this poor performance in mathematics casts doubts about the effectiveness of the research activities to improve students' performance in mathematics.

6.5.4.2 Credibility of the examination system

The authenticity of using multiple choice examinations to assess mathematics learning is of concern here, especially at the Form 2 level. As described above, TS2 did not expect some students to pass the mathematics examination in 1997. However, some of them passed the examination. In other words, the multiple choice examination system as used at the Form 2 level gives little indication about students' abilities and understanding of mathematical ideas. A typical example concerns the assessment of Physical Science at the DEC. Some Form 2 DEC students passed the subject in spite of not having had access to the highly needed practical apparatus to enable students to understand scientific phenomena. During the study, it was observed that students had private Physical Science lessons for only a few hours a week. However, out of 234 students who wrote the examination in 1997, 82 of them, that is, 35%, passed the subject. It is quite likely that these students passed the Physical Science examination through guess work rather than due to having understood scientific ideas. It is also likely that students mastered the science content rather than the processes of doing science. For mathematics, it is quite likely that students guessed answers to questions which required them to use logarithm tables when in fact, due to desperate lack of learning materials, students at the DEC rarely used logarithm tables in their mathematics lessons.

At the Form 4 level, the problem is mainly due to the system emphasising the examination as a selection mechanism, that is, to enable a selected few to get access to further education and participate actively in society. In other words, the mathematics examination at Form 4 is a test for survival, and one that they desperately need to pass, even through deceptive strategies. This results in some very stringent and inhuman measures being taken in the administration of examinations as the following extract from a newspaper article shows:

Two girls who are sitting for the Malawi School Certificate of Education at [a] secondary school in Blantyre said ... they are depressed and psychologically affected following an order from their school authorities to remove their pants and bras as a security measure to ensure that they do not sneak into the examination room
with prepared answers to questions... [It is] a move which they
described as a blatant abuse of their private life. “I was whipped
ruthlessly when they [teachers] discovered I had a bra [on], I think I
have failed the examination paper because they have disturbed me”,
said a girl ... almost sobbing.

Apart from pants and bras, all students are also not allowed to enter
the examination room with sweaters and shoes.

In the wake of mass cheating during exams, the Education Ministry
announced ... that schools must institute “strict” measures to ensure
fair play but ... an official at the [Ministry] offices ... said that what
happened at [the] secondary school was a gross violation of human
rights. (Kaingama, 1997)

6.5.4.3 Teaching and assessment

As described in the analysis, TD2, TS2 and TS4 attributed the poor performance
in mathematics to factors mostly related to student abilities rather than the
quality of teaching at the DEC and the SEC. This suggests that poor performance
in mathematics for these teachers had little to do with teaching, but largely to do
with institutional conditions affecting teaching and learning in the two schools.
Moreover, teachers had little control over assessment procedures. TS4 highlights
this in the following remarks:

When you teach them, at the end they are examined by the Malawi
National Examinations Board. We are not the people examining them.
So you want them to pass those exams. ... We may give [them]
everyday examples which are not examined but they may be
applicable to that topic, but they are not examined.... When the
question comes and it is not exactly as to that, or is not part of [the]
examples that you gave them, they will fail. So you try to give them
an example which is abstract which [maybe] asked by the examiner.
(Notes of Meeting 8, TS2 & TS4, 24/06/97, emphasis added)

The above remarks indicate the fact that in Malawi, assessment and curriculum
development are administered by different institutions. The Ministry of
Education oversees curriculum development activities while the Malawi National
Examinations Board, a largely independent body, control assessment. It is often
the case, therefore, that assessment becomes the driving force for teaching. This is
evident in the comments below from an examiner in Malawi.

Teachers don’t want to waste time on something which is eventually
not going to be examined. And, whether people like it or not, that is a
fact. So we have got quite a big leverage. We decide here what should
be taught in the classroom. (Examiner’s Comments, 6/8/97)

Given the emphasis placed on assessment, it is not surprising that teaching issues
seem to have been sidelined in teachers’ descriptions of their feelings about the
examination results. Consequently, any small improvements in the quality of
teaching may not be appreciated.
CHAPTER 7
POSSIBILITIES AND CONSTRAINTS FOR CHANGE IN
MATHEMATICS LEARNING AND TEACHING BASED ON
THE USE OF EVERYDAY EXPERIENCES

This study addressed the following main question:

To what extent can everyday experiences be used as a vehicle for changing the learning and teaching of secondary mathematics in Malawi?

The analysis presented in Chapter 6 has addressed the following specific questions:

How does the use of everyday experiences affect:

- students' attitudes to, beliefs about and knowledge of mathematics;
- students' participation in mathematics learning; and
- teachers' classroom practices and their views about mathematics teaching?

Answers to these questions have been provided in the analysis and concluding sections of Chapter 6 most of which appear under the title "emerging issues". As discussed in Chapter 6, the intervention produced little immediate change in students' performance in national examinations and teachers' teaching practices. There was little change in students' participation in mathematics lessons.

The first part of this chapter addresses specific issues which came out strongly from the data concerning students' beliefs about and knowledge of mathematics, and teachers' teaching practices and views about mathematics teaching. It was apparent from my own observations and the participants' questionnaire and interview data that there were clearly identifiable sets of constraints operating in both schools.

The next part of the chapter outlines and discusses issues that emerged from the data cutting across the specific research questions and relating directly to the research process. In this way, this chapter provides insights into the possibilities and constraints for change in mathematics learning and teaching in Malawi with respect to the use of everyday experiences, including the learning and teaching conditions identified in the analysis presented in Chapter 6. In discussing these insights, I support each of them with excerpts from participants' data and also
draw on one or more of the emerging issues presented at the end of each section in Chapter 6.

In presenting the findings, I have drawn on the notion of "space" (Pendlebury, 1998) as a construct that indicates whether there is an opportunity — that is, an opening — for changing mathematics education in Malawi based on the research data. In her description of space and time as vantage points for planning change in education, Pendlebury (1998) states the following:

Projects, large and small, are all enabled or impeded by their placement and organisation in time and space. Teaching and teacher education, like other social practices, occur within particular spatio-temporal settings that are partly constitutive of the actions and interactions that take place within them. (Pendlebury, 1998, p. 333)

Pendlebury (1998) analyses educational change with reference to four interrelated "spaces". These are: public space, evaluative space, pedagogic space and institutional space. These spaces specify the "structural and institutional conditions of practice" (p. 337) which need to be examined when planning educational change. The notion of pedagogic space is of critical significance here as it addresses the modes of transmission, and, more generally, the relationship between the curriculum, teaching and learning. More specifically, pedagogic space specifies "what is to count as teaching [and learning] and so partly constitutes teachers' [and learners'] identit[ies]" (Pendlebury, 1998, p. 337).

The aim of this chapter is to present the major research findings and to specify the "pedagogic spaces" which indicate the conditions for changing learning and teaching in general, and, in particular, to explore whether there is space to accommodate the use of everyday experiences as a vehicle for changing mathematics learning and teaching in Malawian schools.

7.1 Learning, teaching and conceptions of mathematics

In this section, specific findings related to students' beliefs about and knowledge of mathematics, and the effects of the research intervention on students' participation in learning are discussed. Insights into teachers' conceptions of mathematics teaching are also presented.

7.1.1 Emphasis on utility of mathematics

The analysis of the first and final student questionnaires indicates that students were mostly interested in the utility of mathematics. This can be seen, for example, in the analysis in Sections 6.1.1.4 (Figure 6.4) and 6.4.1.4 (Figure 6.12), of the reasons why students found it important to learn mathematics. Students believed that acquiring mathematical knowledge would help them to secure
employment and engage effectively in their everyday activities. Typical responses were as follows:

As of now I know maths and I am sure I am going to find a job because of maths, for example a salesman. (D2QB012).

Always, when [I] am solving maths I look forward to my future in my office. (S4QA072).

Students perceived mathematics as being useful to them in their future lives outside school. In Vithal and Skovsmose’s (1997) term, these results demonstrate students’ specifications of their “foregrounds” — that is, what they felt they could do after acquiring mathematical knowledge.

Vithal and Skovsmose (1997) define foregrounds as a “set of opportunities that the learner’s social context makes accessible to the learner to perceive as his or her possibilities for the future” (p. 147). The “foregrounds” of these students related mostly to utilitarian aspects of mathematics.

Although students’ focus on utility of mathematics indicates some potential to use everyday experiences in learning mathematics, there is a need to problematise this perceived utility before everyday experiences can be incorporated into the teaching of mathematics.

As discussed above, students viewed mathematics as important to learn because of its utilitarian aspects. This view of mathematics was a constraint for changing students’ learning. This is because students’ responses indicate their association with taken-for-granted acceptance of societal beliefs about the values of learning mathematics. Students seemed to accept their society’s rationale for learning mathematics. They did not question the value of the school mathematical content to their everyday lives. They are not yet ready to think about the mathematical content they are learning and how it is related to their everyday experiences.

The teaching of mathematics could therefore broaden students’ perceptions of the utility of mathematics by including questions about whether this utility can be actualised. Some Malawian researchers have indicated that the possibility of school leavers gaining employment is “more of a myth than a practical reality” (Msiska, 1994, p. 135). However, students’ socialisation in society, and the fact that mathematics is one of the subjects strongly recommended in order to access jobs and further education, seemed to make them believe that they could still secure paid employment. As one student commented, “when there is an advertisement, maths is the first subject to be taken into account” (S4QA001). Only one student stated that there were very few jobs which they could find after graduation.
Learning maths is important because if a person is doing well in mathematics, he can become an accountant, a chief accountant or a cashier. Such people, although they are in few numbers, are leading a happy life and many companies are looking for such people. (S2QB007)

This focus on utility can also be attributed to the teaching of mathematics itself, which according to Ernest (1986)

has been dominated by narrow mathematical and functionalist aims. A consequence is that mathematics is perceived as isolated from broader social and political issues, and is not used to develop critical thought. This in turn promotes the uncritical acceptance of social norms, or worse still, the ... rejection of social institutions. (p. 16)

However, students' emphasis on the utility of mathematics provides a pedagogic space to accommodate questions about the possibility that they could indeed gain employment, taking into account the tight job market in Malawi as reported by Msiska (1994) and Chimwenje, Bisika and Makuwira (1995). A small number of students felt that it was not important to learn mathematics (see Figure 6.12). They questioned the existence of some topics in their mathematics syllabus. Some of their comments were as follows:

Some topics are useless. There is no need to learn [them]. (D2QA171)

I realised that there are some maths [topics] which are not very important. (S2QB055)

Why did they choose to put [maths] in categories like Algebra, Geometry and Arithmetic and not putting one or else choose one. This always disturbs me. (S4QA014)

Some of the topics in maths are not supposed to be there e.g. logarithms in Arithmetic and Algebra. They are topics that will never help people in their day to day life! (S4QA054)

These students questioned the applicability and legitimacy of mathematical knowledge. Such critique signals a starting point for students to begin to problematise mathematical knowledge and become more conscious of curriculum realities.

The fact that some students questioned the usefulness of Algebra and Geometry shows that they were aware of the constraints of school mathematics. The majority of the students, who in most of the cases benefit little from mathematics (as evidenced by their failure in the examinations; see, for example, Table 6.11), were reluctant to question the "institutionalised knowledge" of mathematics.

7.1.2 Emphasis on success

Students placed emphasis on success as a reason for finding mathematics interesting (see Figure 6.10) and in terms of how they generally felt about their learning at the end of the study (see Figure 6.13). Most students, except for the
Form 4 students at the SEC, felt that they could solve mathematics problems. It
gave them hope to succeed in mathematics. However, this focus on success might
be expected, considering that the students were expecting to write national
examinations at the end of the year.

An important aspect of students’ comments about their participation in this
research concerned the discovery of their identities, that is, who they were and
what they wanted to be with respect to the discipline of mathematics. They saw
that they had the potential to become more “independent” learners (D2QB015),
and, more interestingly, to become mathematicians.

At first I was a fool. I didn’t understand maths. Now I am wise. I
understand because the teacher has changed the way of teaching.
(S2QB116)

Now I see some changes. At least if I work hard, I will be a
mathematician. (S2QB122)

Though [I] am poor at maths, I am trying to be a mathematician.
(S4QB060).

Such students recognised their potential to become members of the mathematics
community of practice. They saw a possibility for becoming active participants in
mathematics rather than viewing mathematics as a subject destined only for
“intelligent people” (D2QB070). However, the Form 4 students at the SEC
consistently felt unsuccessful in their learning of mathematics. This can be seen
from their comments about why they did not find mathematics interesting (see
Figure 6.11). They also felt there was no change in their learning (see Figure 6.13).
This suggests that it was difficult for most of the Form 4 students to feel more
successful about their learning at a stage in their school career when they had
already “switched off” from mathematics. Comparatively, the Form 2 students
seemed as a group, to feel more successful than the Form 4s. This indicates that
there was more potential for the Form 2 students to respond to changes in
instruction than the Form 4s.

Although there was no significant improvement in performance in final
examinations, students’ feelings of success and hope in mathematics made their
participation in this research fruitful.

7.1.3 Students’ attendance and participation in mathematics
lessons

As described in Chapter 6, teachers observed some improvement in the level of
students’ participation in mathematics lessons. TD2 observed that students
participated more in mathematics because more students were turning up for
classes than before. This was due to TD2’s regular attendance in lessons, and the
fact that students had more space to learn. Instead of having all the lessons in
the afternoon in very crowded classrooms, students felt that learning outside the classroom was more comfortable, although this meant that they still had to sit on the ground. Nevertheless, students did not mind sitting on the ground “provided there was teaching” (Research Journal, 24/6/97). What was important for them was the opportunity created for them to learn more mathematics. Students saw their teacher’s regular attendance in mathematics lessons as an opportunity to learn mathematics and to actively participate in lessons.

A different type of participation relates to how students participated in mathematics rather than merely attending lessons. Some students said that they no longer feared mathematics, that is, they did not see the need to run away from mathematics. The following comments, mostly from the Form 2 SEC students, illustrate this.

At first maths was a dangerous enemy. I was afraid [of it]. I also questioned myself that since maths was my enemy and if the teacher came [to class], what was I going to answer? My heart was just beating like someone beating a drum. Now I am able to solve any problem I face in maths. I am going to work extra hard in maths. I would like to encourage you that although we are failures in maths please don’t become bored with us. (S2LEB013)

Previously, when it came to time for maths, I was not feeling well and I use[d] to say to myself, “That difficult subject is coming”. But now, I keep asking, “When is maths today?”. (S2QB052)

Nowadays I am trying my best to solve maths [and] not to miss the time of maths. Mathematics was my enemy subject but nowadays I’m happy because I like it very much. (S2QB94)

Such students became more willing to learn mathematics. Others experienced more freedom to learn and felt that they now had permission to ask questions.

This year there is a big change because we are given time to ask questions compared to last year. (S2QB068)

There is a change because last year when the teacher entered our class, she [wore] a serious face so that we were afraid to ask where we [did] not understood. But now, we are free to ask. (S2QB022)

Each and every student had [a] chance to ask or to oppose and justify his or her point. (S2QB047)

For the Form 4 students at the SEC, there was a small but notable change from saying “we learn in total fear since the teacher challenges” (S4QA035) to remarks such as “We were given a lot of chance to ask questions to the teacher” (S4QB052), and “We had an access of asking questions” (S4QB072).

This represented some liberation from the dominating role of the teacher. Students felt that they were free to “express [their] ideas rather than follow what the teacher said” (S2QB103). It was a departure from the listening role assumed by many students to one in which they felt they had a voice in their learning. Some of the students, especially the Form 2s at the SEC, felt that asking
questions and debating mathematics problems was a better way of learning and one which they hoped could continue in the future (see, for example, the analysis of students' comments on the Average lesson, in Section 6.2.3.2). In Pendlebury's (1998) terms, such students saw a space for deliberation.

7.1.4 Effort into teaching

In their description of how they felt about their participation in the research, the teachers, particularly TD2 and TS2 (see Sections 6.3.2.3 and 6.3.3.4), felt they had put more effort into teaching than before. This is also reflected in how the students felt about their learning at the end of the research. They felt that their teachers had put more effort (see Figure 6.13). In particular, TS2 noted that she had previously been "lazy" and felt that in the future, she would not "go back to being lazy" (TS2, Final Interview, 10/9/97). TD2 felt that he now "put their learning on [his] heart" (TD2, Final Interview, 5/9/97). This shows that the teachers became more aware of their teaching responsibilities and made a greater commitment to improve student learning. This is particularly remarkable for TD2 since he taught in very depressing conditions, with limited resources. As the following comments indicate, facing the teaching situation with courage was important for some students.

I had a teacher who was very courageous to teach me, [more] than last year. (D2QB039)

In this year I've learnt much better than last year because we had teachers who were assisting us so very courageously (D2QB053).

Maths is becoming interesting now because of working hard of our teacher. To say the truth, it wasn't like that last year because our teacher didn't put [much] effort when teaching. (D2QB040)

The above remarks indicate the critical role which teachers play in change in education. As Bruner (1996) states,

No education reform can get off the ground without [a teacher] actively and honestly participating — a teacher willing and prepared to give and share aid, to comfort and to scaffold. Learning in its full complexity involves the creation and negotiation of meaning in a larger culture, and the teacher is the vicar of the culture at large . . . . A major task of any effort at reform — especially the participatory kind — is to bring teachers into the debate and into the shaping of change. For they are the ultimate change agents. (p. 84)

However, there is a need to distinguish between two aspects of teaching as demonstrated by the way TD2 and TS2 felt about their participation in the research. The first concerns the mere presence of the teacher in the classroom. This applies mostly to TD2 since the conditions at the DEC often made teaching a difficult and overwhelming activity. TD2 nearly withdrew his participation in the research because he found the additional teaching tiresome. He had more
lessons to teach and more marking to do. This required considerable effort and
dedication. His students valued TD2’s dedication to teaching and his regular
attendance in lessons. This finding is consistent with research reports from
researchers in developing countries. These reports have found that teacher effort
is the most important factor which boosts students’ success in school in
developing countries (Fuller & Clarke, 1994; Suffolk, 1989).

However, a different aspect of teacher effort was seen from TS2. She commented
that she found that it important to consciously plan her teaching. This meant
“trying harder to prepare for lessons” instead of leaving everything to chance and
saying “I will just see what will happen [when I get to the classroom]” (TS2, Final
Interview, 10/9/97). During the teaching sessions, it meant trying different
methods, and having a flexible mind to ensure that students grasped the
mathematics concepts.

I go to a class and [teach] the way I feel it will be OK for the
students. If I realise that they seem not to have understood, I try to
use another approach. So I go there with a flexible mind, to say that if
they won’t get it this way then I [will] think of another way for them
to understand. (TS2, Final Interview, 10/9/97)

Although implementing change in teaching required considerable effort, it is
significant that TD2 and TS2 demonstrated willingness to do more in order to
improve student learning. This willingness and space in their thinking about
teaching could be nurtured to support change.

7.1.5 Teachers’ conceptions of teaching and learning

One of the aspects TS4 considered important when beginning to teach, was the
need to assess whether the students were in the right mood to learn, that is,
whether they were ready to “receive” the message she had “brought”. This
indicates TS4’s sensitivity to students’ motivation towards learning. However,
this sensitivity appeared to have limited scope. As described in Section 6.3.3.4,
TS4 used motivation techniques to gain control of the class. Motivation played
an instrumental role — that is, to create space for her to “talk”, to silence
students and to tighten up spaces available so that students could listen. In
Freirian educational discourse, this relationship represents the “banking concept”
of education (Freire, 1972, p. 46). Surveying students’ attitudes to the teacher is
synonymous to ensuring that the “bank” (that is, the student) is open before the
teacher could make the “deposit” (that is, communicate the mathematics
content). The purpose of the motivation context (that is, jokes) was to secure
students’ cooperation rather than enhance or stimulate students to make
meaningful links in mathematics.
While the above analysis demonstrates the intention of motivation, it also reveals the values and limitations of institutionalised knowledge about teaching communicated in teacher education. TS4 constantly associated her classroom actions and decisions with her previous training and beliefs about teaching. She appeared to value and follow her teacher education knowledge unreflectively.

A different form of controlling discourse concerned decisions about who speaks and when, in class. For TS2, all students were expected to answer questions, to pay attention and not have their minds "wander off" during teaching.

There are some [students] who will be dreaming and they know that you can't pick them because they haven't raised their hand. So they might be [mentally] out of class .... They are supposed to be following what is happening in class, unless we can say [that] in a democracy one can choose to listen [or] not. But we expect those in class to be listening. If they don't want, why not go out? (TS2, Final Interview, 10/9/97)

In so doing, TS2 did not recognise that dialogue was a human activity, that is, that "human existence cannot be silent" and that students do not exist "in silence but in word ... in [both visible and invisible] action [and] reflection" (Freire, 1972, p. 61). Requiring students to be awake and not allowing their minds to wander off denies students' existence as "whole persons" (Lave & Wenger, 1991, p. 53). TS2 seemed to believe that students needed to disengage from reality in order to participate effectively in the classroom. She viewed the classroom as a different environment from everyday life. While TS2 valued students' participation in class, this seemed to be more mandatory than voluntary. This is likely to lead to chorus responses in class as observed by many researchers in developing countries (Fuller, 1991; Harber, 1990; Vulliamy, 1990b). Fuller and Snyder (1991) have confirmed the dominance of the teacher in most classrooms in developing countries. They found that teacher dominance gave students little opportunity to engage in more empowering activity than recitation, response to closed questions and simple recall. Consequently, "students rarely speak up in class with queries of their own" (p. 292).

TS4 wanted students to speak only when they had a question. They had to raise their hands when they had a problem or did not understand something. Raising hands regulated classroom discourse. This is different from the democratic mode of learning in which classroom talk is assumed to be a natural part learning.

When you want to speak, you start talking, without raising your hand, and if others speak at the same time, you look around at each other's faces and regulate yourselves without waiting for the teacher to decide who should speak in what order; you do this by deferring to each other, by looking around and asking yourself if it's your turn to speak or if someone else should go ahead of you .... Through self-regulation, students mutually establish the order of speakers, instead
of it being done by the teacher. Self-regulation means that they share responsibility for maintaining dialogue. (Shor, 1996, p. 69)

TS2's and TS4's beliefs about the role of students in the classroom contradict the above assumptions. Establishing a culture of dialogue in the classroom was largely dependent on the teacher. Students did little else than follow the teachers' actions. Any dialogue was considered as "noise".

The above discussion shows that teachers had transmissive and authoritarian views about learning. Their explicit suppression of freedom in learning, may lead students to fail to recognise the values of inquiry-learning strategies when these are being introduced as part of classroom practice.

### 7.2 Constraints to change

In this section, three major constraints to change in student learning and teachers' classroom practices are discussed. These concerned the mathematics assessment, teaching and learning resources and institutional contexts in the schools.

#### 7.2.1 Assessment

For some teachers, then, the presence of examinations seems to constrain them in their approach to classroom teaching; it limits innovation and inhibits their willingness to explore new teaching strategies. Achievement-conscious [students] may conspire with their teachers in this process of limitation too, drawing them back to safer pedagogical ground when exploration threatens to divert them from their examination destination. (Hargreaves, 1988, p. 221)

Assessment was a major constraint in the teaching and learning of mathematics observed in the two schools. It constrained the way students felt about their learning. It also affected teachers' teaching practices and constrained the way they evaluated the effects of the research intervention, particularly in terms of students' examination results. I discuss these constraints below.

##### 7.2.1.1 Students' feelings about assessment

I feel depressed because when I learn maths I feel [like] I will get [it] right, but when I do [an] exercise, I always fail ... . I benefit much only during [learning] time but when it come[s] to writing tests, I feel as if I learn nothing. I always fail. (S4LED039)

Poor performance in classroom tests constrained the way students felt about their learning. They felt that they had enjoyed lessons and understood the content but could not solve mathematics problems. This is shown by the number of students who felt unsuccessful in learning (see, for example, Figure 6.13). Students did not value their learning unless it helped them to pass mathematics tests or complete exercises. Assessment limited the range of possibilities
regarding what students felt they could do after learning. Essentially, assessment tells them that they cannot succeed at mathematics.

Poor performance in tests affected the way students felt about assessment. Students generally viewed as suspect any problems which they perceived as deviating from what they considered to be the norm. They wanted problems which were similar to examples they had been given in the classroom.

- Please give us some problems that are similar to the [classroom] example. (D2QA079)
- We [are] given problems totally contrary to examples. This makes [us] think beyond age-level licensed capacity and gradually, [we] get bored and stop [learning]. (S4QA054)
- We need to be given soft problems first [because] there is need to soften the brains we have, then harden [them] later. (S4QA007)

Students did not value challenging problems, indicating that they had a limited conception of what it meant to know mathematics, what they believed was important to learn, what needed to be assessed, and, more generally, what they believed they should be doing in mathematics. According to Borasi (1990, p. 176), the scope of mathematical activity for such students consists of "identifying a correct answer to a well-defined problem that has an exact and predetermined solution". The nature of mathematics consists of "recalling and applying learned procedures to solve problems". Mathematical knowledge consists of "facts and procedures that are fixed, predetermined, and not subject to human judgement". In general, "mathematical knowledge exists as a finished product; the duty of the [student] is to discover that knowledge" (p. 176).

However, it is quite likely that the type of mathematics problems students saw in their textbooks and examinations constrained their conceptions of assessment. In his analysis of mathematics textbooks in Malawi, Heddens (1995b, p. 3) concluded that "too much review material is presented in the textbooks". A significant proportion of this review is assigned to previous examination questions which mostly involve recall of theorems, proofs and execution of routine mathematics procedures.

### 7.2.1.2 Teachers’ assessment practices

The results described in Chapter 6 show that TD2 shifted his thinking from teaching for the examination to teaching for general knowledge. TD2 saw that mathematics teaching and learning transcended the boundaries of the examination. He saw that learning mathematics also needed to be useful for future employment and everyday life, and be important for the sake of gaining knowledge *per se*. The interaction between TD2 and me seems to have made him question his teaching focus and thinking about learning. This awareness provided
TD2 with the "pedagogic space" (Pendlebury, 1998) in which to explore the use of everyday experience in teaching mathematics. However, this apparent shift in thinking seems to be unsustainable. It was noted that institutional conditions exerted pressure on TD2 to focus on the examination. The DEC Principal wanted TD2 to ensure that more students passed the mathematics examination. In addition, the poor performance of students in the final examination results, although it was better than the previous year (see Section 6.5.3.1), is likely to prevent TD2 from continuing to engage in activities which involve linking school mathematics with everyday experience. This lack of success in mathematics examinations is likely to force TD2 to attend to the examination requirements.

TS4 claimed that she found it important to use examinable problems as well as practical problems when assigning exercises to her students. Although the use of practical problems was seen as not being in conflict with her practice, the fact that TS4 used practical problems as "additional" suggests that she considered them as being at the periphery rather than centre of her classroom practice. This is seen, for example, from her having deliberately chosen to teach the topic Arithmetic Progressions before Probability since she believed that the national examinations covered Arithmetic Progressions in more detail than Probability (Research Journal, 10/8/97). In addition, during the formulation of classroom tests, TS4 made sure that the types of questions she gave students were similar to the examination type. She did this by repeating some of the previous examination questions (Research Journal, 9/6/97). In so doing, TS4 was conforming to the practices of the Malawi National Examinations Board. This practice seems to be consistent with the beliefs of one Malawian examiner who felt that teachers did not have any choice but to teach for the examination. Teaching quality was judged by teachers' capacity to make students succeed in examinations.

Teacher effectiveness is judged by how well the students perform in the examinations. Here in Malawi the transition from primary to secondary school, the percentage of those who go to secondary school is very important. So each teacher, [and] each school where there are more candidates selected to go to secondary school, then the community says this is a good school. So the teacher has no choice because that is the only evaluation they have of their performance. That is the only evaluation they have which tells the public, even the teacher himself that he is doing a good job — [that is], judging by how many students have passed, and even better, how many have been selected. So the teachers have no choice [but] teach to the examinations, because that is the only external evaluation which will give a feedback to the public and the institution. So they are forced to teach to examinations. Otherwise they can become very practical but if the exam does not measure those practical issues, the teacher is bound to teach according to examinations. (Interview with an Examiner, 6/8/97, emphasis added)
By paying deliberate attention to the examination system used by the Examinations Board, TS4 was prepared to maintain the status quo, to serve the interests and assumptions of the examiners rather than question the educational values of assuming an examination-driven pedagogy.

Although teachers appear to have shifted from teaching for the examination to teaching for general knowledge, this shift appears to have been limited and temporal.

The pressure of the examination limited teachers' appreciation of the value of using everyday experiences in teaching mathematics. TS2 expressed strong reservations about the value of using everyday experiences. She did not seem to value the affective evidence that she observed from her students. TS2 made the following remarks:

> Using everyday examples has changed the attitudes of the students. When we use the examples, they seem to visualise the whole thing, to connect [with] real life ... That helped them to understand what you would bring across. At least they found the lessons interesting because they would see its applicability. But we will be able to see the effect on their performance when they write the exams. (TS2, Final Interview, 10/9/97)

This underscores the vulnerability of the approach of using everyday experiences. This is also reflected in de Lange (1993a) study in which he reported that many of the teachers and researchers questioned the effectiveness of the Realistic Mathematics Education approach. They remarked:

> [We] like the way you have embedded your mathematics education in a rich context, but [we] will wait for the national standardised test to see if it has been successful. (p. 198)

According to TS2, it was important to see the effect of the approach on the examinations. However as described below, TS2's reaction to the final examination emphasises the lack of credibility of examinations.

### 7.2.1.3 Credibility of national examinations

As described in Section 6.5, the Form 2 students at the DEC and the Form 4 students at the SEC performed poorly in their mathematics examinations. Although students, particularly those at the DEC, felt that they had learned much mathematics to enable them to pass the examinations, they did not perform as expected. TS4 was surprised that some of her best students failed.

The purpose of these examinations is of crucial importance here. Given the poor performance of students (although they did better than previous but still not as well as expected), the examination seems to inform students that they cannot pass the test. The poor performance communicates the message that students
cannot do mathematics. This is unfortunate, particularly given that the evaluation is based on rigid and timed examinations. These examinations concentrate on written and abstract problems which do not relate to students' realities. For example, the following were some of the sixty multiple-choice questions given to the Form 2 students during the 1997 mathematics examinations (Malawi National Examinations Board, 1997, pp. 3, 5).

Q18: Chimwemwe is 4 years older than Temwa. Temwa is six years older than Mabvuto. If their combined age is 49 years, find the age of the oldest person.
A. 17 years    B. 21 years    C. 28 years    D. 31 years

Q29: A certain company employs 120 men and 80 women. If the average wage of a man is K14.00 per hour and the average wage for a woman is K11.00 per hour, find the average wage of an employee per hour.
A. K12.80    B. 13.00    C. K13.25    D. K13.75

Q33: Apples costing K70.00 per 10 are mixed with oranges costing K20.00 per 10 so that a profit of 20% is made by selling at K48.00. Find the cost price of the mixture.
A. K38.00    B. K40.00    C. K45.00    D. K50.00

While the above questions may be appropriate for routine problem solving, it is unlikely that they could qualify to be called problems, particularly in the sense referred to by Cooney, Davis and Henderson (1975) who state that

For a question to be a problem, it must present a challenge that cannot be [solved] by some routine procedure known to the student .... It follows, then, that a question may be a problem for one student and not for another student .... A challenging question becomes a problem to an individual only to the extent that the individual accepts the challenge. It follows, then, that for a question to be a problem the student must be motivated to answer it. (p. 242, emphasis in original)

It is quite clear that the above questions were not “problems” if the student had memorised the procedures for solving them. The values which the above questions might communicate about mathematics and the reality they represent, are of critical importance here. The above questions can be argued to communicate the message that mathematics is about arbitrarily mixing quantities irrespective of the everyday meaning of the activity. Question 18 quoted above is likely to mean that not only do companies employ more men than women, but they also pay them differently. If this is not considered problematic, it might legitimize existing inequalities in society.

The point here is that if an attempt is made, during mathematics lessons, to examine questions like the above for their meanings in society, this might be a starting point for shifting education away from “maintenance and reproduction toward critique and transformation” (Frankenstein & Powell, 1994, p. 81).
Such problems are likely to be meaningless in reality and could communicate contradictory meanings about mathematics. For example, while TS2 observed that the examinations were about social stratification, she remained unconvinced about the main aim of the examinations.

Maybe the (Malawi National Examinations Board) exams are there to classify people, [to select] who will go to the next level. They classify them and then that leads them to different employment ... So they classify people by those exams. One who has failed the Junior Certificate Examination will not be the same as one who has passed the Malawi Certificate Examination. So exams are like check points. We want to differentiate people. But I don’t really know what their aims are. (Notes of Meeting 8, TS2 & TS4, 24/6/97)

The second issue concerns the Form 2 students at the SEC who demonstrated, in terms of pass rates, that they did better than their counterparts at the DEC as well as at the same school in 1996 (see, for example, Table 6.12). As discussed in Section 6.5.3, TS2 suspected that these results were flawed since she believed that students had guessed answers or cheated in the examinations. The implication here is that the examination results do not reveal what students know and can do in mathematics. Rather, the results reveal what students can do in order to succeed in mathematics, irrespective of whether they had learned or understood mathematics. It represents a situation in which assessment and learning are separate aspects of mathematics education, and, while teachers may exercise control over teaching and learning activities, the national examinations remain beyond their control. These examinations lacked credibility and meaningful connections to everyday life.

7.2.2 Teaching and learning resources

Students placed emphasis on the lack of resources such as time, textbooks and classroom space as needing serious attention in order to improve teaching and learning of mathematics in the two schools. This can be seen from Figure 6.5 (concerning students’ feelings about how they thought mathematics could be made more interesting), Figure 6.6 (concerning the factors which students felt contributed to the difficulty of mathematics), and from Figure 6.14 (concerning aspects students liked most during the learning of mathematics in the year of the research study). Specifically, the Form 2 students at the DEC appreciated the fact that they had more time to learn mathematics, that they benefited from having an additional teacher (the researcher), and the fact that they were given some handouts and worksheets during teaching sessions.

We have learned more and you have helped us with some other materials such as handouts which we were using when we were dealing with some other topics which were needing books. Instead you were giving us handouts to use. So I can say that this year we have learned more and better rather than last year. (D2QB024)
As several education researchers in the developing world have illustrated, learning materials such as textbooks are one of the most important resources for teaching given the limited professional training and scarcity of teachers (Dove, 1995; Fuller & Clarke, 1994; Fuller & Heyneman, 1989; Fuller & Kapakasa, 1991; Suffolk, 1989). As Dove (1995) explains,

The average schools in developing countries have teachers with inferior opportunities for professional upgrading and classrooms starved of good teaching aids, books, and materials. Such conditions practically dictate chalk-and-talk teaching methods, and, in political terms they model authoritarian, passive cultures. They certainly cannot nurture problem-solving, imaginative, and innovative teaching and learning. Unless, therefore, governments find the will and resources to provide equitable access to the new pedagogy for all the teachers, stratification of schools may deepen. (p. 196)

The problem of resources is complex, and one which adversely affected teaching and learning in the two schools involved in this study. An analysis and understanding of the way teachers utilise classroom tools, in order to glean "what teaching tools actually mean in the eyes of teachers and students" (Fuller & Clarke, 1994, p. 142), is of crucial importance here.

A major constraint during teaching sessions at the DEC was the fact that students often came to the classroom without anything to write on. Many of them often complained that they did not have protractors, pencils, compasses, rulers or other materials such as graph paper. This affected students' learning since some of them just sat without writing anything, and, consequently, benefited little from teaching. Due to economic constraints, some of these materials could simply not be made available to the students. However, there were occasions when it was possible to use students as resources, to ask them to collect materials that could be used in the lessons. For example, since the DEC did not have any duplicating machines or photocopier, it was difficult to make squared paper available to all students. Faced with this problem, TD2 and I asked students to make their own squared paper. The following notes show my frustration at attempting to persuade students to be resourceful.

Today I was persuading the Form 2 students at the DEC to produce their own squared paper. I have been urging them to do this in order for them to generate their own resources for graph lessons. Students resist doing this, to produce their own materials, to help themselves. This clearly shows the difficulties of achieving change, especially when students are used to being given handouts and resources. It is difficult to change people, just as it is difficult to achieve change without materials. (Research Journal, 1/7/97)

However, some students felt the need to help themselves, and volunteered, for example, to improvise chalkboard dusters. The point here is that students and teachers need to see how they could still improve learning with the minimal
resources they have. Better utilisation of available resources can enhance learning and teaching.

However, when resources are utilised inappropriately, they may constrain teaching and learning. As discussed in Section 6.2.5, teachers may not use the resources available to them in the ways intended. For example, while TS2 and TS4 had agreed to place on student noticeboards the handouts that illustrated the connections between the topic Inequalities and situations in everyday life, they decided to keep the handouts to themselves instead. Having finished teaching the topic, the teachers felt that it was not necessary for students to know more information about it. The teachers felt that the materials were more useful for tests than providing extra reading for students. This indicates that TS2 and TS4 believed that students did not need to know beyond what they had learned in class.

Although the Form 4 students at the SEC had mathematics textbooks, TS4 believed that students should not be allowed to use them since they would distract them from listening to her.

When you are teaching, they [students] don’t have that chance of using textbooks ... They [do] not normally use the textbook but it is for you the teacher ... Because the problem is that when you say open page so and so, and then you try to write down an example on the board, most of them will not listen. They will just be interested in reading the book. So that is why I am not often using the textbook in the classroom. (TS4, Final Interview, 8/9/97)

TS4’s beliefs about the role of mathematics textbooks constrained the way she looked at student learning. She believed that students needed to pay attention to her, to focus on the blackboard rather than consult any book during teaching sessions. While TS4 regarded the textbook as an important resource, the way she viewed its use in relation to learning symbolises the power of the teacher to maintain control. It shows that the teacher was more important than an other source of knowledge. Consequently, students may believe that the teacher is the most important source of knowledge. Hence while the textbook provides an important resource for learning, at least for students who may not have access to the teacher, the way the teacher uses the textbook might constrain the way students perceive their learning and their classroom behaviour.

The other constraint concerns the ability of teachers to examine the relevance of the resources they have for learning. Several researchers have demonstrated the need to consider resources as problematic because of the meanings which resources communicate about learning. More specifically, it is important to analyse the values inherent in mathematics education (Bishop, 1991; Bishop &
Clarkson, 1998; Swadener & Soedjadi, 1988; Wilson, 1986). In this regard, Bishop (1991) has noted the following:

Many teachers and others in education seem to believe that mathematics is value-free knowledge, and therefore it is rare to find a mathematics classroom in which values play an intentionally significant role, or a mathematics textbook in which there is any serious discussion about mathematics, or a school examination in which questions about mathematics are asked. Mathematics in school still seems to be, in the majority of cases, a performance subject, where skills are emphasised, and such values which are being developed throughout a pupil’s mathematical education are destined to remain hidden, unknown and unanalysed by an education which doesn’t question and doesn’t provoke. (p. 196, emphasis in original)

As described in Section 6.2.5.1, TS2 followed the textbook and used prescribed problems without questioning. Her use of the textbook was limited to the mathematical content in the problem. No other links were made about the appropriateness and relevance of the problem to real life.

An analysis of teaching resources can also provide information related to the goals and methods in mathematics education. For example, the distance education booklets for Form 2 students at the DEC contain the following advice:

Mathematics can be difficult to learn... It is only by working through many problems in maths that you will come to understand it ... You can only learn to do maths by practising! (Malawi College of Distance Education, 1986, p. 1, emphasis in original).

The above quote could suggest to students that mathematics is largely a performance subject that needs regular practice in solving discrete problems. Hence while resources may be enabling, they also constrain teaching. Adler (1998, p. 166) has argued that

effective teaching (becoming a full participant) ... depends not only on the availability and use of a textbook, but also knowledge of and insight into its history and inner workings, its possibilities and limits.

An examination of resources to uncover their hidden meanings and how resources are used can be a starting point for knowing more about teachers’ thinking about mathematics. This creates space in which to learn more about teaching and to find out aspects of teaching which need to change.

### 7.2.3 School norms

Teachers stated that they found it important to put more effort into teaching than before. This realisation was important for them and was highly appreciated by their students (see Figure 6.13). However, for TD2, the determination to put more effort into teaching — that is, to teach more — appears to be unsustainable due to the prevailing conditions at the DEC. As a result of teaching frequently, TD2 feared that his colleagues would consider him a better teacher than them.
They would say: why is he taking himself as the best teacher here?
One day, a certain teacher said: “Why are you taking my time?”
Because the students will not write only mathematics. They will write
many other subjects ... So with that mentality, it is very difficult for
me to [do more teaching] ... Because once they see me [going] there
they just say “mathematics again!” (TD2, Final Interview, 5/9/97)

While participation in the research provided TD2 with valuable knowledge about
teaching, it was risky and alienating in terms of how his colleagues perceived his
changed practice.

As a result of his participation in the research, TD2 saw that he needed to be
attending to the students more than previously. This resulted in his regular
attendance in class and doing more teaching. However, TD2 felt that his
colleagues considered his willingness to teach more as a sign of undue pride.

TD2 observed that other teachers at his school made sure that he did not use up
too much of their lesson time. They made sure that they stopped him when his
lesson time had expired, to make sure that he concluded his lesson on time.

While TD2 observed that his regular attendance in class encouraged other
teachers to do more teaching as well, there were other teachers whom TD2 felt
regarded his regular attendance as “showing off” — that is, showing off that he
was a “better teacher than his colleagues”.

Effectively, TD2 was working in an environment which potentially had two
opposing groups: one that valued his “changed” practice (that is, teaching more),
and the other that wanted him to do less teaching, to assume “normal”
classroom practice. This latter group fits rather well with Postman and
Weingartner’s (1972) description of change constraints when they say:

There are [people] who ... are threatened because they have identified
themselves with certain ideas and institutions which they wish to
keep free from either criticism or change. Such [people] as these
would much prefer that the schools do little or nothing to encourage
youth to question, doubt, or challenge any part of the society in which
they live, especially those parts which are most vulnerable. “After
all”, say the practical [people], “they are our schools, and they ought
to promote our interests, and that is part of the democratic process,
too”. (pp. 15-16, emphasis in original)

The teachers at the DEC are likely to have viewed TD2’s position as “more
privileged”. They possibly felt that TD2 was gaining more knowledge, hence he
was destined to be in a more advantaged position than them. A positive change
in teachers’ knowledge about teaching may lead to alienation from their
colleagues, contrary to some research findings such as those by Meighan and
Habor (1986). In their study, they found that

The [teachers] were surprised at the pay-off from the course which
seemed to more than offset any expected responses of alienation and
rejection. The [teachers] approached the teaching practice with considerable confidence and this was remarked upon by [other] teachers in the school (p. 170)

While there was potential for TD2 to implement his gained knowledge, it was likely that this gain in knowledge was temporary. This presents a space in which further awareness is needed. As TD2 says, his colleagues “wished they were involved in the research” (TD2, Final Interview, 5/9/97).

The above tension was not observed by TS2 and TS4 at the SEC. This may be due to the fact that most of the teachers at the SEC already had diplomas and first degrees. They were more qualified than the DEC teachers. For TS2 and TS4, their involvement in the research was possibly not considered by their colleagues as a threat. Nevertheless, without supportive institutional conditions, change in teaching practice is likely to have a limited impact and be threatening.

7.3 Research issues

In the next sections, I present major findings which are directly related to the research process in the two schools. I highlight the constraints on and prospects for collaborative research and discuss the conditions which enhanced or hindered collaborative research in the two schools. I discuss the possibilities and constraints I envisage for the design and implementation of collaborative research in contexts similar to Malawian schools.

7.3.1 Disruptive nature of the research process

In a discussion of classroom research, Cohen and Manion (1980) point out that

It is frequently the case that the type of observation undertaken by the researcher is associated with the type of setting in which the research takes place. (p. 123, emphasis in original)

In this study, the quality and quantity of the observation data appeared to relate to the differences in resource provision in the two schools. As described in Section 5.1.3, the SEC was relatively well resourced. It had spacious classrooms, student desks, and chalkboards. The DEC lacked most of these resources. This shortage and quality of chalkboards greatly affected the teaching sessions at the DEC. TD2 and I often spent time looking for a portable blackboard to run classes outside the classroom (see Appendix 2). Much teaching time was lost in the process. When we had secured a board, there were also problems during the teaching sessions themselves. Students often had to endure learning in the sun, and, sometimes rain disrupted classroom sessions (Research Journal, 16/7/97). In spite of these problems, students still attended classes since they believed that the important thing for them was to see that there was some teaching. Students
were accustomed to these situations. As Fuller (1991) has observed, teaching outside the classroom is a common practice in Malawian schools. Fuller observed the following at one Malawian school:

One third of all classes are taught outside, where the teacher stands with blackboard in hand .... Clusters of children, each numbering 50 to 120, appear across the grounds sitting on the beaten-down, red-clay ground, beneath sparse trees that buffer the African sun’s penetrating intensity. (p. 79)

The aim here is to question what counts as a classroom, and, in particular what might count as doing classroom research, especially in impoverished settings like Malawi. It appears here that, just as teaching involves struggling together with students in order to “create conditions for the construction [and] reconstruction of knowledge” (Freire, D’Ambrosio & Mendonca, 1997, p. 9), so does research. Doing classroom research in the DEC context implies ensuring that there was some teaching before I could study teaching. It involved setting up the conditions for learning to take place before I could carry out research.

In Chapter 5, I stated that TD2 often required my assistance when teaching, especially when he found that he needed to respond to students’ questions whose “answers” he was not sure about. In so doing, I ended up teaching more often than I had anticipated. Because of this, I had little time to observe what was going on in the classroom. Also, TD2 did not make any detailed observations, but made very brief verbal comments such as “the lesson went very well” (Research Journal, 9/6/97). At the DEC, teaching took greater precedence over research goals. This resulted in my obtaining fewer recorded observations at the DEC than at the SEC.

The conditions at the SEC were more enabling for teaching and conventional classroom research than at the DEC. At the SEC, teachers had the necessary resources such as textbooks and blackboards (although, as discussed in Section 7.6, the way they used resources, for example, textbooks, was rather limiting). In addition, since TS2 and TS4 had adequate knowledge of mathematics, I observed more lessons for TS2 and TS4 than I did for TD2.

However, the quality of the observation data obtained was not as expected. As explained in Section 5.2.1, teachers had already made plans on the topics they were going to cover. Most of these topics (see Table 6.5) did not involve the use of everyday experiences. Hence, I collected little data about the use of everyday experiences in the classroom. Also, the way the teachers taught the lessons meant that I spent more time reacting to what was happening than making a detailed and “distanced” documentation of classroom events. On certain occasions, I made suggestions during the teaching sessions, for example, by asking a question or making a remark, so that some discussions about mathematics could take
place. The suggestions were aimed at getting some data so that I could make more meaning about how students were feeling about learning in the classroom. In some cases, as can be seen below, the teachers appreciated the "interruption".

WM: What do you feel were the highlights of our working together?

TS2: What I appreciated most was where you would go to class and be part of the class, not like an inspector, where you would be posing questions, interrupting me, and so on. I appreciated that. I have been able to learn from your comments.

WM: Didn't you find that disturbing, because sometimes it would be something that you had not thought about at that time, and you were in front, [teaching]?

TS2: Mostly, it wasn't a question to me. It would be for them [students] to think about. I appreciated it because it was something which I didn't think of but it was related to what we were doing... It was like making [me] know that it was related to that.

WM: So you found that [useful]. But in terms of time maybe some of that would sort of move you away from what you would be covering.

TS2: But that's the reality. That's what I take as the reality of the situation. Because one shouldn't go to class to say I am going to cover this and nothing should come in. (TS2, Final Interview, 10/9/97, emphasis added)

Hence the situation at the DEC needed conditions to be made more favourable so that some teaching could take place before I could do any research. On the other hand, at the SEC, there was more timetabled teaching and the appropriate classroom setting for this to happen. The problem there was to struggle with the abstract nature of the mathematics content and the way the teachers taught it. The differences in the research settings in the two schools resulted in differences in research outcomes.

Additionally, differences in the understanding of the research rationale affected the way lessons were taught and observed. In designing the research, the aim of using everyday experiences was to enable students to make connections between mathematics and everyday life, and to facilitate discussion about mathematics and its connections with everyday events. For example, on the topic: "Use of square root tables", the idea was to question the value of learning about the topic itself, that is, to ask questions about the extent to which logarithm tables are used in everyday life. This would enable students to discuss the limitations of using tables compared to other ways of carrying out computations such as using pocket calculators, which are quite common in the streets and the workplace. A discussion of this nature would be more useful than the textbook-focused teaching which teachers seem to have assumed. However, instead of having a general discussion about the topic, the teachers seemed to have wanted something that they could write on the board as an example, "the mathematics".
They wanted something that they could present to students as a task or problem they could solve as an exercise. They did not seem to value the "unwritten" discussions which took place in the classroom. For example, in Lesson 10 (29/5/97), while there was some discussion about the use of geometrical constructions in building, TS4 did not mention this link in her observations. In Lesson 15 (4/6/97) on the topic Bearings and Distances, while TS2 had observed that a link was made with the use of sunrise and sunset to locate directions, her comment: "Are realistic examples necessary?", indicates that she possibly did not see the purpose in making the link. This indicates that teachers seemed to differ in the focus they had in their observations of lessons. They focused more on the mathematics content of the lesson rather than on the reflection, discussion and links that the use of everyday experiences prompted (See Appendices, 17a, 17b and 17c). In addition, as the following comments show, the teachers did not have time to make (detailed) observations and reflections about lessons because they had other issues to attend to. However, when they had time to reflect, their focus was mostly on delivery and performance.

TS2: Our concentration is more on delivering. At the end of the lesson, sometimes we don’t write comments [in diaries] because [we] would want to wait for the results. [We] had given them an exercise to see what they have got from there ... We give them an exercise and see from their performance you check if they have understood. Also, if I give an exercise, I mark, I note the mistakes but sometimes I don’t have the time to put them down. I just have them in my head. It’s not difficult, but like myself I find that I am preoccupied. I have some other things which I have to attend to. So I just note those mistakes, but putting them down sometimes I have problems finding time when to put them down. But I have them in my mind.

TS4: We are preoccupied. But when we are free, we will be able to write down what is in our heads and write down in the diaries.
(Notes of Meeting 18, TS2 & TS4, 15/8/97)

The teachers had a different focus which indicates the ways they understood the purpose of using everyday experiences in the classroom. As mentioned above, my aim was to enhance understanding and enable students to make links between mathematics and everyday life. However, as can be seen below, it seems that for the teachers, at least in the case of TS4, the aim was to enable them communicate the content "fast”.

WM: So how did the use of everyday examples fit your pattern of working in the classroom? How did it affect how you were handling the classroom?

TS4: The use of everyday examples helped me to give out the information and the pupils were receiving the information with more interest. Because they were connecting the information with whatever they see, and it is real ... So the use of everyday examples was making my teaching fast.
WM: So they would catch the ideas fast.

TS4: Yes. (TS4, Final Interview, 8/9/97, emphasis added)

While it is clear from the above comments that TS4 perceived the purpose of using everyday experiences as enabling students to become interested in the mathematics of the syllabus, it is also clear that she saw the purpose as fitting with her teaching approach, that is, to teach in such a way that students "receive" the information "fast". Rather than "reject" the approach of using everyday experiences, TS4 "appropriated" it to "fit" her teaching intentions and aspirations: the way she hoped students could respond to her teaching. Brown et al. (1993) have distinguished between the processes of "appropriation" and "internalisation" as follows:

The term "appropriation" is used in place of "internationalisation" because of the widespread belief that use of the term "internalisation" (1) merely renames a learning mechanism that is not understood and (2) implies that the fruits of learning, although initially gained in social interaction, somehow come to reside in individual minds. (p. 192)

Accordingly, TS4 "understood" and "appropriated" the use of everyday experiences as fitting with her belief that she needed to train students to be fast learners, and that the use of everyday experiences helped her communicate ideas fast. Although such a motive may be questionable, it was consistent with her understanding of learning and how students ought to operate in the classroom.

Such an understanding of the purpose of the use of everyday experiences seems to have affected the way TS4 (and the other teachers) commented on lessons, especially when they felt that the lessons were not moving as fast as they had wanted. Their focus was on the pace of lessons rather on other issues such as open discussion and its values.

The above discussion highlights the fact that teachers do reflect on their practices. However, their (reflective) knowledge about teaching is informal and "unwritten". In TS2's terms, it is "in their heads". It also emphasises the point that their focus on classroom reflection is about matters most relevant to their concerns such as performance. As Northfield (1998) has argued,

Teachers begin with comprehensive "big picture" aspirations as they strive to understand teaching and learning. Frequently, their studies begin with classroom concerns which represent persistent dilemmas and difficulties ... Establishing better learning behaviours, developing more valid assessment approaches ... and improving learning outcomes in practical classes are examples of the complex areas which teachers seek to study and improve. They are reluctant to focus on more narrowly defined areas, as they remain aware of the complexity and uniqueness of their classrooms and the way many factors interact in these settings ... For most teachers, the primary purpose in studying their teaching is to teach more effectively in their
own classroom setting. The academic's (quite legitimate) primary purpose is to contribute to the knowledge base by publishing to an audience of other academics. (pp. 1, 2)

However, the teachers' reflections on classroom practice, at least in the case of TS4, conform to a transmission model of teaching and learning, to academic performance and reproduction.

### 7.3.2 Prospects for collaborative research

There were two important aspects of the collaborative nature of the research process. The first concerned its potential to develop some knowledge and understanding about learning. Secondly, effective teacher-researcher collaboration depends on the degree to which participants have ownership of the research. I will discuss these two issues below.

#### 7.3.2.1 Knowledge production

This research involved three teachers — one teacher (TD2) at the DEC, and two teachers (TS2 and TS4) at the SEC. Having involved only one teacher at the DEC facilitated as well as constrained the nature of our collaboration. Involving only one teacher at the DEC meant that I only had one class to deal with, and hence fewer lessons to teach. This gave me relatively more time to reflect on and plan the research process than if I had another teacher at the DEC. However, involving one teacher at the DEC affected the quality of the interaction we had in reflective meetings. This is because in most of our discussions, his responses were limited to my questions. The meetings lacked a sense of spontaneity which could have been achieved if I had an additional participant as was the case at the SEC. Also, due to teaching constraints at the DEC, TD2 and I spent most of the time discussing mechanical issues and immediate organisational problems of the classroom rather than detailed discussions about the aims of the research and the rationale behind the use of everyday experiences in teaching mathematics.

Involving two teachers at the SEC, although constraining since I had more classes to teach and observe, proved very useful. This was for two reasons. Firstly, as mentioned in Section 5.1.4, TS2 and TS4 had studied mathematics at university level. They had richer experiences of mathematics than TD2 who only had an equivalent of an O-Level qualification (4 years of secondary schooling). Due to their experiences and knowledge of mathematics, they had interesting views about mathematics teaching and learning. For example, TS4 felt that in mathematics, she "works from the truth" and does something which is true since mathematics follows logically. This view of mathematics seems to have influenced TS4's beliefs about what students should be doing in mathematics and
the way she observed lessons. On the other hand, TS2 had a more "flexible" view of mathematics and appeared ready to accommodate alternative approaches to teaching. She was willing to be "interrupted" during lessons.

Consequently, this study yielded more insights about mathematics teaching in Malawi from the interaction between TS2 and TS4 than from TD2, although their accounts of mathematics and teaching were quite close to conventional models of schooling practices. This can be seen from an analysis of the teacher interviews presented in Sections 6.3.2.1, 6.3.3.1 and 6.3.3.2.

Secondly, the interactivity of the discussions facilitated by the presence of two teachers at the SEC enhanced my research role more than was the case at the DEC. At the SEC, I had more opportunities to record insights during our discussion meetings. I also had more time to listen to what teachers said and to pose questions for discussion.

The interactivity of my meetings with TS2 and TS4 also resulted in my having documented detailed cases about teachers' understanding of deeper issues about mathematics learning and their relationship to the investigation. For example, TS2 asked: "What do we mean by learning? If we say somebody is learning, what do we mean?" (Notes of Meeting 14, TS2 & TS4, 5/8/97). In her response, TS4 claimed that "where there is teaching, there is learning .... Learning is when one is getting information and is able to reproduce it". As shown below, TS2 and TS4 had different views about learning and assessment.

TS4: When it comes to learning in school, we can test that students have learnt something by their performance. That is the only test.

TS2: That is a check, and in that case we are saying learning as acquiring new ideas. We check by giving them a test to see if what we gave them has got into their brain ... Sometimes an exam doesn't give a good picture of what students have learnt because sometimes the questions are just restricted. Somebody has got something which maybe you haven't asked in that test. If exams were like: "write what you have learnt about this", somebody would write something. So if we look at learning in a broad way then maybe it is more fair to those students who have not understood what they have been asked, but have, maybe, understood what has not been asked. (Notes of Meeting 14, TS2 & TS4, 5/8/97)

During this discussion, it became quite clear that while TS2 had relatively flexible views about learning (as "acquiring ideas"), TS4's expressed views were quite restricted. She talked in terms of boundaries and "safe spaces" (Bostrom, 1998) of her practice. Nevertheless, this difference of opinion set a context for and stimulated more debate about the concept of learning. We planned a meeting to enable us to reach some "consensus" about the meaning of learning. During this meeting, further questioning by TS2, supplemented by references to specific
classroom episodes, made TS4 to change her views from considering learning as “receiving” and being able to “reproduce” information to viewing learning as an “active process” that involves “more than what can be measured by tests or exercises” (Notes of Meeting 18, 15/8/97). Appendix 26 shows a detailed discussion that TS2, TS4 and I had about the concept of learning and the interrogation that assisted TS4 in changing her ideas about learning.

Having more than one teacher from the SEC in the research enabled this study to obtain richer insights about teaching than was possible at the DEC. This interaction revealed differences between TS2 and TS4 in terms of their understanding of learning. The role of TS2 was crucial in terms of providing a safety net, that is, a “deliberative space” (Pendlebury, 1998) through which TS4 could articulate her views without possibly feeling the pressure of an outsider, the researcher.

7.3.2.2 Research ownership

Effective collaboration needs the researcher and participants to be both “in” and “out” of the research setting. There are three levels at which I felt I was either “in” or “out” of the research setting in which I worked. The first level concerned the students, who seemed to have recognised and valued the working relationship their teachers and I had. The following comments illustrate this.

As of now maths is very interesting because of your presence here at the DEC. You have made us to achieve something, and when I try to compare with other subjects I can see that we will finish [the syllabus]. I enjoy myself when I am learning maths nowadays.

(D2QB074)

The system you have introduced is quite good to me and my friends. Now you are walking and solving the problems together ... . As you walk together, each one of you tries [your] best to make us understand what another teacher hasn’t made clear. For example, the problems of 2nd July 1997 on Averages I was quite [happy with] the methods which you have introduce[d]. (S2LEA003)

The collaboration with teachers was important since it ensured that they were covering more material than would be possible with only one teacher.

Apparently, this was particularly important for examination purposes.

It’s better to have two or three teachers in examination classes than one teacher. Because if you don’t understand what the first teacher [said], you ask the second teacher. (S2LEA048)

In this way, there was a sense of appreciation for my “presence” and teaching assistance. Hence I felt I “belonged” to the setting. However, there were occasions when I felt I was “out” of the setting, for example, when confronted with classroom situations which contradicted my views about learning and the type of mathematics I felt students could be doing. As an example, the Form 4 students
at the SEC made the following request: "Please, Sir, tell us what is needed in mathematics for one to do well in examinations" (Research Journal, 24/6/97). Students wanted me to "coach" them on how to succeed in mathematics examinations. I was in a dilemma. While I was there to assist them in their learning, students' thinking about learning was not consistent with mine since they demanded that I assist them to review previous examination questions (from the Malawi National Examinations Board) which were mostly abstract and had little focus on the connections between mathematics and real life, which was of direct concern to my study. However, their teachers generally felt comfortable with such requests. For example, in Lessons 66 and 69, TS4 and TD2, respectively, spent all of the lesson time revising examination questions. This was not surprising, as assessment greatly influenced teachers' teaching practices. This happened in spite of having discussed with teachers the shortcomings of curriculum instruction being assessment-driven. Nevertheless, this showed that teachers were, in spite of my presence and the research project, free to make decisions which best suited their teaching requirements and students' needs. This indicated that the teachers had complete authority and ownership over their classroom practices.

Although this questions the extent to which research can change practice, it emphasises the point that teachers need to feel that they are free to choose the pedagogical modes that best suit their situations, even if they may be in a research "contract". This can be seen in the following comments from TD2 who, initially, did not wish to make detailed comments about the effects of the research intervention on students' learning because he saw the research as mine.

WM: What do you feel has been our aim, the main thing that we have been able to achieve so far?

TD2: I think to my side ... it's very difficult to add something. It's up to you because you are the one to [judge]. I know the aim. You wanted the students to use their everyday life [experiences], what they observe, what they've seen, to use it in the learning of mathematics ... There are some topics which we can't use activities like fractional indices. But so far now, to your goals, have you achieved? (Notes of Meeting 12, TD2, 30/7/97, emphasis added)

Not surprisingly, the research was generally seen as mine. However, there was some collaboration since the teachers felt "in" as well as "out" of the intervention. The teachers remained in control of their practices in addition to attending to research matters.
7.3.3 Constraints to collaborative research

A major constraint to the research process which can threaten collaboration efforts concerned the lack of "educational" awareness and the poor working conditions of the research participants.

As discussed previously, the collaborative nature of the research design contributed positively to the research process. Teachers and students felt that they benefited in various ways as a result of their participation in the research. However, there were also some undesirable and potentially devastating consequences of this collaboration.

At the DEC, problems occurred on the part of some students who did not feel successful, and those who seem to have equated the quality of teaching with performance in tests and examinations. TD2 made the following recollections:

I remember one day when I was giving students their marked papers. I said "You have ashamed me. Failing like this!" Then one [student] said, "Then it means you are not teaching" .... I was affected because if a student says, "You didn't teach", maybe it's true. He said, "You need to prove your teaching". (Notes of Meeting 12, TD2, 30/7/97)

This incident occurred because some students felt that they had failed a test because they felt it was too demanding as it required them to be reflective rather than guess answers to questions. Although TD2 and I set the test together, TD2 received most of the blame for students' failure since he was their class teacher. This incident clarifies two things. Firstly, students were resisting being more reflective in their thinking. They wanted to solve "straightforward" and procedural problems which cannot enhance critical reflection. Secondly, and most critically, it shows that involving TD2 in this way of teaching, that is, requiring students to be more reflective, had the undesirable potential to alienate him from his students if they did not do well in their assessment tasks.

A more serious and unanticipated level of alienation brought about by the research intervention concerned TD2's relationship with his colleagues at the DEC. As can be seen below, his colleagues appreciated the nature of the collaboration he had with me. Some teachers envied TD2's involvement in the research apparently because they felt he was getting more professionally "educated" than them.

WM: How do other the teachers look at what we are doing?

TD2: They are appreciating. They are admiring, admiring that they wished they were them. Because someone was saying "You will learn more, [and] much better, because he [the researcher] is assisting you. And, after he has left, you will be more knowledgeable". (Notes of Meeting 12, TD2, 30/7/97)
Although TD2 reported that other teachers showed great admiration for him, he strongly felt that he did not see his need to talk to them about the research. He felt that his colleagues would not show any interest in the research. They would not see the value of it. Instead, they would be more interested in knowing whether TD2 was getting any material rewards by participating in the research.

**WM:** Don’t you think we need to brief them about what we are doing in this research?

**TD2:** [Explain] to these teachers? No. It's better to explain to the Principal. You already explained to him. But as far as I know, my fellow friends, it's not good to let them know. They won't accept... They would say you're just blinding us... But with me there is no problem because I am after knowledge concerning my subject. So for them they just wanted to see why [I am] accepting? “Is he getting something?” ... So to my side I say “No, nothing. I am getting nothing from you”. (Notes of Meeting 12, TD2, 30/7/97, emphasis added)

Two issues are clear from the above comments. TD2 feels that his colleagues would not be bothered to know more about the research. The fact that TD2 thought that his colleagues would feel they were just being "blinded" implies that what was valuable for them were the material rewards rather than knowledge about teaching. However, this might be expected since the DEC teachers receive very meagre salaries (Research Journal, 12/8/97). Hence getting “financial” rewards took precedence over matters concerning teacher development and student learning. The DEC teachers described themselves as “failures, poorly trained, and lacking skills and knowledge” (Research Journal, 12/8/97). It is, therefore, ironic that they did not want to value collaborative professional development activities. It is not surprising, therefore, that TD2 felt rather alienated from his colleagues since he felt that they would not “accept” his professional advice. The following comments show this.

**WM:** After this experience, would you be able to organise some of your friends and help each other like we have been doing?

**TD2:** After this, of course I can do [work with others] but with my fellow teachers here, for me to try to make a short meeting with them, telling them that we have to work [together], do this and that, they can’t accept me. Maybe it would be possible [in] another school, because they would say “He was at such and such a school”. They [wouldn’t] know how many years I was here, so they [would] just take it for granted that maybe I spent a lot of years there ... But not the same teachers as here. (TD2, Final Interview, 5/9/97, emphasis added)

Essentially, TD2 felt that working collaboratively with others, at the present school would not be viable, since he felt that his colleagues would consider him as lacking capacity to influence them. He also felt that they would say, “Are you trying to say that we are not teaching?” (Notes of Meeting 15, TD2, 6/8/97)
In contrast, the teachers at the SEC (that is, TS2 and TS4) not only demonstrated greater ownership of the research, but they also felt very positive about sharing the research ideas with their colleagues at their school. They said the following:

TS4: We can tell them during tea time. We can ask them to also tell us the effects of using everyday examples in their subjects. It was a good idea because they may be in a position to tell us the effects of using everyday examples in their subjects, the importance to students or everywhere. We would like them to comment on whether this is worth doing. Maybe some of them know what we are doing, but they don’t know what we are applying.

TS2: I don’t mind if they know what we are doing. (Notes of Meeting 14, TS2 & TS4, 5/8/97, emphasis added)

The above differences and constraints are enormous and cast doubts as well as prospects about the institutional conditions of practice which might enhance teachers’ willingness to work collaboratively and learn from one another, especially in poor, fragile, and professionally malnourished educational environments in developing countries like Malawi. As Harper (1990) has pointed out, in educational situations where teachers are underpaid, poorly rewarded and face large classes with limited resources, it is not surprising that their attitudes to the additional effort involved in the implementation of new methods of critical pedagogy are either negative or quietly resistant or reserved.
CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

This study investigated the extent to which everyday experiences could be used as a vehicle for changing the learning and teaching of secondary mathematics in Malawi. Chapters 6 and 7 have shown that there was very limited change in both students’ learning and teachers’ teaching practices. Although a few possibilities for change were noted, the analysis showed that teaching mathematics using everyday experiences met with several institutional and curricula constraints.

The aim of this chapter is to highlight the conditions which show that the learning and teaching of secondary mathematics in Malawi has some potential to change, and, in particular, to highlight the possibility for mathematics teaching in Malawian schools to incorporate the use of everyday experiences. This chapter also describes the obstacles for change, outlines the limitations of the study, and makes recommendations for further investigation and reform of secondary mathematics education in Malawi.

In the final section, I reflect on my thesis journey, what I feel I have personally learned by doing this research, and the implications of this for my engagement in mathematics teacher education.

8.1 The utility of mathematics

The students involved in this study had very utilitarian views of mathematics. They viewed mathematics as being useful and important to learn so that they could gain future employment and participate effectively in their everyday activities. The utility of mathematics seems to be the main reason why most of the students found it important to learn mathematics despite their lack of success in it. This is an important finding since it signals a group of students who want to learn mathematics only if it is useful and who might find mathematics more enjoyable if it is taught in a way that shows it to be useful. However, as discussed in Chapter 7, this utilitarian view of mathematics appeared to be a myth, since very few opportunities exist for students to secure employment after graduation. This utilitarian view is a reflection of societal beliefs about the motivation for learning mathematics, and serves to perpetuate and legitimate the taken-for-granted functionalist notion of mathematics.

Consequently, this utilitarian view of mathematics provides an opportunity for the teaching of mathematics to question the taken-for-granted functionalist perspective of school mathematics. As discussed in Chapter 6, the mathematics
topics which the teachers were dealing with were mostly abstract and had very little connection with everyday life. While students felt that learning mathematics was important for future employment, very few of them questioned the relevance and applicability of the content of mathematics to their everyday lives. This conflicting view of the utility of mathematics presents an opportunity for mathematics teaching to incorporate a discussion of the limitations of studying a decontextualised body of mathematics for the majority of students who neither pass it nor gain employment. The aim here is to conscientise students — that is, to enable them to gain a "deepening awareness of the socio-cultural reality which shapes [their] lives (Freire, 1974, p. 51). This could be a more empowering motivation for learning mathematics than one that focuses on rote memorisation and recall of decontextualised and disconnected mathematical content.

8.2 Perceptions of mathematics teaching and learning

An important finding concerns teachers' perceptions of the value of using everyday experiences in teaching mathematics. T52 believed that the use of everyday experiences enabled students to appreciate and visualise the connections and applicability of mathematics to reality. She believed that students saw mathematics as part of their everyday lives rather than something that is external to them and learned only in school. T54 believed that teaching mathematics using everyday experiences enabled her students to construct a "real picture" of mathematics. In other words, rather than focus their teaching on prescribed textbook content, the teachers were able to experiment with other ways of teaching mathematics. This seems to have made a difference to student learning and teachers' beliefs about teaching and their roles in the classroom. Teachers appreciated the value of framing mathematics teaching in the lived experiences of their students rather than in the artificial representation of reality portrayed in their curriculum and institutional expectations of working in mathematics.

Teachers began to think differently about teaching, to see mathematics teaching in a broader way which included linking mathematics with everyday experience. For example, when introducing particular topics in lessons, teachers made an attempt to ask students questions such as "Do you see logarithms being used in everyday life? Do people use four-figure tables in everyday life?" In so doing, the teachers considered the mathematics content presented in textbooks as problematic. They found it important to ask the question: Why should students be learning about logarithm tables, and what other aspects should they be learning about instead? Why should DEC students, for example, still be learning about the use of four-figure tables when they do not and possibly never will have
adequate resources to learn about these, given the endemic structural and
financial constraints confronting schooling in Malawi?

Teachers began to value the experiential aspect of mathematics learning, to ask
students whether the mathematics they learn in school is related to their
experiences in their everyday lives. However, the question that needs to be asked
concerns the extent to which teachers can continue this inquiry and the process of
explicitly linking mathematics teaching with reality, bearing in mind the context in
which these teachers are working. Two key issues need to be considered here.
Firstly, for this linking process to become a valid component of teachers’ teaching
practices, the use of everyday experiences must be seen to be offering a better
way of learning. However, it needs not be associated with narrowly inherited
ways of working in mathematics such as in the case of TS4 (described in Section
6.3.3.6). TS4 saw the use of everyday experiences as enabling her to teach faster
in spite of differences in students’ abilities to cope with her teaching pace. TS4
did not seem to recognise that the main purpose of using everyday experiences in
the teaching of mathematics was to build from what students’ already knew and
make mathematics learning more connected to their everyday experiences.

Secondly, and related to the above, change in teaching must start with an
interrogation of teachers’ beliefs and thinking about teaching. The teachers had
very textbook-driven approaches to teaching and demanded that textbooks
include the use of everyday examples related to the mathematics content. As a
start, teachers need to see the use of everyday experiences as belonging to a set of
goals for knowledge production rather than as culturally insensitive reproduction
of mathematics content through the textbook and examinations. The use of the
textbooks must not be seen as an end in itself, as following curriculum standards.
Textbooks must be conceived as representing a way, among others, of working
with mathematics.

8.3 Constraints to change: A case for assessment-led curriculum reform?

As a result of taking part in this study, some students felt more successful and
felt that they had more freedom to participate in mathematics. In some cases this
was due to teachers having put more effort into teaching. However, as the
following comments indicate, such changes were transitional and momentary.

We have learnt maths well but I cannot appreciate that I see some change. (D2QB073)

The way the lessons were being conducted gave me a certain change
but it did not reach at the point which I [thought] I [got] all the
information about maths. (S4QB010)
In Chapter 7, I discussed a number of constraints to the use of everyday experiences as a vehicle for changing the learning and teaching of secondary mathematics in the two schools involved in this study. The most notable constraint was assessment. There are three sources of evidence for this.

Firstly, students felt quite negatively about their learning due to their poor performance in classroom tests and exercises. They felt they had enjoyed learning and understood the mathematics content, but could not solve mathematics problems. Students viewed with suspicion any problems which they perceived as deviating from the type they considered to be the norm. They did not want to be given challenging problems. They wanted to solve problems which were similar to examples they had done in class.

Secondly, students demanded classroom assignments and tests of the type similar to the final examinations. Nevertheless, students' demands to be given exercises of the examination type enabled this study to yield crucial information about the role of everyday experiences. This was obtained from one of the critical events in the research concerning students' responses to the Average lesson (discussed in Section 6.2.3). An examiner from the Malawi National Examinations Board specifically stated that teachers teach what the Board examines. This legitimated students' demands regarding assessment.

Thirdly, although teachers appear to have made some shift in their approaches from teaching for the examination to teaching for general knowledge, this shift was limited since they constantly made reference to meeting examination requirements as the main reason for not fully implementing the use everyday experiences in their teaching. The teachers were forced by the institutional pressures to teach to the examination. For example, the DEC Principal wanted TD2 to ensure that more students passed the mathematics examination. In assigning classroom tests, TS4 deliberately repeated some of the previous examination questions since she discovered that the Malawi National Examinations Board also repeated previous examination questions.

Although TS2 believed that students had changed their attitudes to mathematics as a result of their participation in the research, she expressed strong reservations about the value of using everyday experiences. She was ready to appreciate the value of using everyday experiences if they improved students' performance in the final examinations. Ironically, TS2 did not consider students' performance as genuine when in fact the final examination results for her students showed a marked improvement over the previous year's results. Contrary to the expectations of TD2 and TS4, students did not perform as well as expected in
their final examinations in mathematics in comparison to the performance of TS2’s students.

I believe that the above remarks present a strong case that for change in learning and teaching to take place, there is need to change assessment practices in Malawian classrooms. Although this might be difficult to achieve as has been illustrated by various researchers, change in assessment needs to be seriously considered in Malawi, where no serious attempt has been made to reform the national examinations. The following aspects need to be considered.

Firstly, there is need for a critical examination of the value and credibility of using multiple-choice examinations at the Form 2 level. This practice must be seriously revisited, possibly abandoned and replaced with assessment methods that require students to demonstrate their thinking about mathematics, rather than memorisation and haphazard recall of knowledge and facts. As de Lange has reiterated (see, for example, 1993a, p. 205; 1993b) “we must abolish multiple choice once and for all”.

It needs to be noted that the Malawi National Examinations Board introduced multiple-choice examinations in 1995 because they believed that multiple choice tests “cover a wider range of the syllabus” and, consequently, “force teachers to teach the whole syllabus without leaving some parts of it” (Interview with an Examiner, 6/8/97). However, if multiple choice continues to be used, it must be framed in such a way as to allow students to reason rather than reproduce facts. Students need to be given, at least at the classroom level, the chance to formulate or pose their own problems. Two models of assessment that might be appropriate here concern the use of problem-posing strategies advocated and implemented in critical mathematics education studies (Frankenstein & Powell, 1994; Hoffman & Powell, 1989; Kibi, 1993). These strategies include activities which involve students in writing about mathematics: to reflect on the process of “doing and thinking about mathematics and on their feelings in relation to mathematics” (Hoffman & Powell, 1989, p. 132, emphasis added). These strategies are both open-ended, in order to make visible what students understand or do not yet understand, and have a “mathematical focus” which ensures that students still cover the content they need in order to satisfy their curriculum requirements.

The second model also involves reflection and uses students as evaluators of their own and learning. This model is illustrated in several publications on assessment the most recent being the volume by Beesey, Clarke, Clarke, Stephens and Sullivan’s (1998) titled Effective Assessment for Mathematics. According to these authors, given a mathematics problem, students need to be asked not only to give correct answers, but also to give answers which some students might give
as being correct while they are not. Students are then asked to explain why the answers are correct or incorrect. This process allows students to demonstrate their problem-solving abilities and understanding of mathematics.

Rather than impose questions which students should solve, students need to be given opportunities to ask their own questions. The role of the teacher, together with the students, is to show how the types of questions given in their textbooks and examinations do not further their understanding of mathematics and its connections to real life. If students are not allowed to ask their own questions, to have some ownership of the assessment processes, it is not surprising that they will continue to regard assessment questions as unfair and beyond their capabilities.

The Form 4 students at the SEC felt unsuccessful and experienced very little change in their learning of mathematics. In addition, as discussed in Section 6.5.3.3, comparing students' performance with those of the Form 4 students in the previous year, shows a big decline in their performance in the final examination results. It needs to be noted that some of the Form 4 students had possibly already given up mathematics and were learning it only because it was compulsory. It might therefore be reasonable to consider offering a different track of mathematics that would suit the needs and aspirations of students. However, I believe that this process in itself might constitute stratification and classification of students, and might prevent some students from gaining access to certain disciplines of mathematics. Rather than propose that different tracks of mathematics be offered at the Form 4 level, as suggested by Heddens (1995), I propose that due to the critical shortage of professionally trained mathematics teachers in Malawi, there should still be only one track of mathematics. Offering different tracks of mathematics could be seen as discriminating between those students who are pronounced as successful learners and those who are not. It could be tantamount to declaring that some students can while others cannot do mathematics. Instead of tracking the curriculum, the goal could be to make the current mathematics content interesting and meaningful enough so that students are empowered to decide for themselves why they really need to learn it.

Given the extent to which assessment constrained the teachers' and students' thinking about mathematics, a critical examination of the assessment procedures currently being used in Malawian classrooms is needed. Without this, changes in teaching to accommodate reflective and critical approaches promoted by the use of everyday experiences will be difficult to attain and sustain. As Hargreaves (1988) has pointed out,

...
influence ... the continuing pervasiveness of transmission styles of teaching in the school system. Their removal or reform will bring no automatic pedagogical shifts, only the creation of opportunity for alternatives to be explored more thoroughly. (p. 221)

8.4 The need for more teacher collaboration and expansion of the notion of collaboration

Teachers and students viewed the collaborative planning and teaching of mathematics lessons as an important aspect of the study. TS2 personally commented that a sharing of ideas between herself, TS4 and me contributed to changes in her thinking about teaching. This underscores the need for teachers to participate in the research process and the value of teacher-researcher collaboration in terms of its potential to provide teachers with opportunities to gain more knowledge about teaching and to reflect on and examine their current practices more critically.

However, there is the question of the extent to which appropriate teaching cultures exist in the schools to enable the teachers to continue to experiment with and put into practice the knowledge gained from their participation in the research. There is a need to question the taken-for-granted assumption of the existence of shared teacher cultures, an assumption which is pervasive in the literature on professional development in school systems. Hargreaves (1994) interrogates the assumed existence of a shared teacher culture and notes two problems as follows:

First, the existence of shared culture is presumed in any organisation being studied, no matter how complex and differentiated. All organisations, it is thought, have cultures. This is not a finding but a presumption. The possibility that some highly complex organisations may have no shared culture of any substance or significance is not acknowledged. Second, the theoretical and methodological emphasis on what is shared in the organisation may exaggerate consensus-based aspects of human relationships, according them an importance in research studies that outweighs their significance in practice. In some organisations, the differences, conflicts, and disagreements are more socially significant for the participants than what they may happen to share ... This is often true of secondary schools, with their balkanised relations between departments ... In this sense, ... the form of teacher culture, the pattern of relationships among its members is as important as the content of any shared beliefs within that culture. (pp. 189–190, emphasis in original)

As discussed earlier, TD2 felt that he could not put into practice the knowledge he had gained from his collaboration with me. TD2 feared that his colleagues at the DEC would think that he knew better than them. He felt that they would consider involvement in experimenting with new methods as a waste of time, and that no one would appreciate the value of what he was doing. Furthermore, by saying that his colleagues would not listen to him, he felt that his colleagues
would not see him as possessing enough credentials so that he could be listened to. Ellerton and Clements (1998) have argued that

Just as centre-to-periphery models of curriculum change are likely to be actively resisted by teachers, so too are recommendations emanating from research carried out by persons who are perceived, by teachers, to be too remote to understand the pressures shaping what is possible in school mathematics programs and classrooms. (p. 170)

However, there is a strong indication from TD2 that his colleagues wanted to listen to someone from the top, someone better qualified or more credentialled than them. This is a strong case for the propagation of a top-down approach to education change, contrary to current thinking in mathematics education reform which advocates a more grounded and bottom-up approach.

The above description strongly indicates that teachers cannot fully participate in curriculum change and teacher development activities unless they have supportive, cultural and deliberative spaces in which to do so. There is a need for institutional conditions which value change and not regard change as threatening and alienating.

The context of the DEC calls for teacher collaboration that involves a wider cross-section of teachers. A model of teacher collaboration which might be useful here is one from the Project for Enhancing Effective Learning (PEEL) in Australia (Baird & Mitchell, 1986; Baird & Northfield, 1992). The PEEL project employs a method of group-based action research, whereby teachers, assisted by university researchers, act together to research and improve teaching and learning based on problem areas identified by teachers in their everyday classroom situations. It needs to be noted here that the PEEL project approach was instituted and found to be successful in situations where schools have adequately resourced classrooms, so that the primary goal has mainly been the focus on improvement in student learning. On the contrary, schools in Malawi do not have the basic resources which need to be available at least as a starting point for talking about change in learning. Hence, a model of collaboration suggested here is one that calls for the need for teachers to work together so that they could generate their own resources and be more aware of what they can do for themselves in their own context, rather than wait for the Ministry of Education to supply resources as has been suggested in recent calls for change in secondary education in Malawi (see Chapter 2).

8.5 Change in teacher education programs

The teachers in this study assumed different "cultural spaces" in their thinking about mathematics and classroom practice. TS4 was very articulate about how
she needed to be working in the classroom, and what students needed to be doing, apparently in recognition of how she was trained. She embraced the idea of using everyday experiences and fitted it with very traditional, limited and psychological views of teaching and learning. TS4’s beliefs about mathematics and classroom practice appeared to be framed by her beliefs about mathematics teaching as propounded in her teacher education experiences. TS4 viewed mathematics as “truth”, an objective and logical discipline. She appeared to like mathematics because of its objective and logical nature, and believed that students needed to be working in this way. TS4 had an articulate view on mathematics that embraced a way of working, a logic which she wanted students to engage in and develop. However, this position is rather limiting, particularly as it has roots in psychological discourses which ignore the social and political spaces in which students make meaning of reality and construct their identities (Nespor, 1994).

In light of the above constraints there is a need to urgently re-examine the discourses to which teachers are exposed during their teacher education programs. It is prudent to include more critically conscious teaching discourses than the ones with a psychological bent currently pervading mathematics education. In psychological discourses, the learning of mathematics is portrayed as a process through which students learn an objective, high-status body of knowledge. The teacher’s role is seen as simply one of providing the quickest means through which this must be achieved. In psychological discourses of teacher education, there is little space for problematising the nature of teaching and learning. The knowledge of mathematics is seen as legitimate and a necessary license for membership in the practice of mathematics and acceptance in society.

As Abraham and Bibby (1992) have indicated,

> teacher [education] fails to equip teachers with the capacity to construct and/or sustain an alternative to the custodial control approach in the face of practical and professional pressure to be seen as a competent teacher. (p. 193)

In teacher education, critical discourses are neither acknowledged nor conceived and developed as appropriate teaching methodologies in spite of their recognised importance in developing countries undergoing democratisation and political reconstruction.

### 8.6 Limitations of the study

This study had a number of methodological limitations. The most critical ones concern the study time frame, the process of implementing the use of everyday experiences as a vehicle for changing learning and teaching, and the methods of collecting and analysing the student data. I will describe these in turn.

This study took place over a period of five months. Given that the first two weeks of the study was used for negotiating the research in the two schools, and the last part for negotiating to leave the field, the actual amount of time used in
the implementation of the research was less than the five months planned. Also, due to time limits during research activities, few opportunities existed for teachers and I to conduct detailed discussions about the philosophical assumptions underpinning the use of everyday experiences as a vehicle for changing mathematics teaching and learning. The use of everyday experiences was clearly not part of teachers' academic traditions and pedagogic repertoires. TS4, for example, was still tied to her teacher education discourses which appeared to have paid little attention to critical pedagogies and the use of everyday experiences. This was possibly why the teachers had different foci in their observations of lessons. Teachers needed to have a more grounded pedagogical and theoretical repertoire than I had imagined would be sufficient by having weekly meeting discussions with them.

Given this time constraint, this study was considered to be a study designed to describe the status of secondary mathematics education in Malawi, a "small-scale intervention in the functioning of the [actual classroom] and a close examination of its effects" (Cohen & Manion, 1980, p. 174). The aim was to study change by providing some stimulus for teachers and students to change. The outcomes of such an interaction would be useful to inform change initiatives, that is, to indicate the possibilities and constraints for achieving change in the context in which that change is being planned. Although the study achieved limited change in learning and teaching, the insights about change gained from this study were therefore worthwhile.

The second limitation concerns the fact that this study was implemented in examination classes. As discussed previously, assessment greatly influenced teachers' and students' thinking about mathematics. Students placed much emphasis on success in their examinations. Teachers frequently regarded the examination as the most important aspect to consider when teaching. This examination focus is likely to have been due to the fact that the participants were in examination classes. This most likely forced teachers and students to pay more attention to the performative rather than the affective dimension associated with the use of everyday experiences. However, using participants from examination classes was inevitable. As discussed in Section 5.1.3, the mathematics teachers in Forms 1 and 3 were student teachers on teaching practice. I wanted to work with teachers who were permanent members of staff in the schools. Nevertheless, having taken place in examination classes, this study provided many insights about the constraints of assessment, as assessment is at the centre of most mathematics curricula. As Woodrow (1997, p. 14) has acknowledged, assessment is "the only [aspect] that is not neglected by teachers".
A third limitation concerns the use of questionnaires in the collection of student data. Questionnaires have generally been associated with quantitative research paradigms, and have been criticised for their inability to provide analytical accounts of participants' views. In this study, I used questionnaires to collect student data, for example, concerning their feelings about mathematics and learning at the beginning, in the middle and at the end of the study. However, I believe that the decision to use questionnaires was both technically and ideologically appropriate. I wanted to get students' written responses, in English, so that I would not face the enormous task of transcribing and translating the interviews. By using questionnaires, I was also able to get data from as many students as possible in order to get a profile of their views about mathematics.

This study did not include any transcriptions from interviews I had with some students. This is because most of these students felt more confident to use Chichewa (a native Malawian language) during discussions. The conversations had a mixture of English and Chichewa. I did not use these in my data analysis, although I listened to the taped versions. Nevertheless, most of the data from my informal discussions with students confirmed what students had described in their written comments at various stages of the study. Translating these and making sure that they represented "objective" accounts of the taped versions was not possible, given the time constraints and limited opportunity to validate the transcripts with individual students after returning to Australia.

Fourthly, in the analysis of the questionnaires, I focused on the aspects on which students placed much or little emphasis. In so doing, the analysis excluded some intermediary aspects in order to attend to others which were more directly related to the aims of the study. For example, I needed to have an extensive analysis and discussions of students' perceptions of the utility of mathematics, since this was closely linked to students' perceptions of the value of using everyday experiences in their learning. In other words, it was not possible to discuss all categories of responses from the questionnaires.

The inherent bias and subjectivity of qualitative research approaches such as case study is therefore acknowledged. As Walker (1983) has argued,

Case studies tell a truth not the truth. They may offer certain claims to truth, depending on the nature of the evidence they provide, but they are always partial accounts; constructions of reality; representations. [However], they may well become part of the culture they describe, in that they provide shared memories and perceptions of their subjects. (p. 165, emphasis in original)

Hanrahan (1998, p. 316) also points out that "participating collaboratively in research means that single voices lose some of their individual perspective and
become part of a shared perspective". However, having focused my discussions on aspects such as success in and utility of mathematics, I addressed both the main concerns of the study and the concerns and constraints imposed by the institutional contexts in which teachers and students were working.

8.7 Further research

In light of the findings of this study, I make a number of recommendations for further research. Firstly, it would be appropriate to retain the small and situated nature of the study and extend it to other mathematics teachers in secondary schools in Malawi. However, given TD2's reservation about his collaboration with his colleagues, a group approach to teacher change and research is urgently needed at the DEC. It would be important to conduct an ethnographic study of the schooling cultures that might prevent DEC teachers from engaging in teacher collaboration. It would also be important to investigate the extent to which working more collaboratively at the DEC might change teachers' values regarding research and self development.

This study has shown that TS2, who did not have exposure to any formal teacher education, was flexible in her approach and accommodated teaching suggestions. On the other hand, TS4, who had undertaken formal teacher education, was quite conservative in her approach. A second area for further research concerns the need to investigate, on a detailed scale, the effect of previous teacher education on teachers' preparedness to accommodate alternative pedagogies. There is also a need to explore how the level of teachers' mathematical knowledge might be related to their preparedness to accommodate alternative teaching methods such as the use of everyday experiences.

A third area for investigation concerns the fact that very few students questioned the absence of connections between school mathematics and everyday life. If students are made more aware of this lack of connection, to what extent would they be more prepared to reject the belief that school mathematics is a useful tool for everyday life (e.g. boosts employment prospects) when, in fact, most of them do not even gain the employment they aspire to? Would students find connecting school mathematics to everyday reality a valid goal for learning mathematics given the dominant role of the examination? What could be the effectiveness of making students aware of the explicit connections between between school mathematics and their experiences in school and society?

A final research area for investigation concerns the lack of resources in the teaching and learning of school mathematics. This study has shown that lack of learning resources was a major constraint in teaching and learning in the two
schools. The DEC lacked learning resources to a far greater extent than the SEC. As explained in Chapter 2, according to the distance education policy, students at the DEC are not supposed to be formally taught but to study programmed self-instructional learning booklets. The question here is: Why did the Form 2 students at the DEC put more emphasis on poor teaching and shortage of teachers than on the lack of other learning resources such as textbooks while the policy of Distance Education advises students to rely on textbooks rather than face-to-face teaching? To what extent do DEC students perceive themselves as distance learners as assumed by the Malawian distance education policy?

8.8 Reflections on my thesis journey

In this section, I reflect on some of the important ideas I have learned in my research journey. I reflect on the dilemmas of doing research, and on what this research has meant for the teachers and students in this study. I make these reflections in order to accommodate the "personal" aspect of engagement in research, an aspect commonly ignored in conventional research reports (Hanrahan, 1998). Mason (1998) has used the following metaphor to highlight the personal development aspect of research outcomes.

Research reports tend to be like describing a car journey from a helicopter: major turns and traffic conditions may be reported, but not the views seen and moods experienced by those inside the car. Researchers very rarely report on, much less communicate transformations in themselves. (Mason, 1998, p. 370)

Walker (1983) argued that "one of the [inevitable] qualities of case studies is that they usually reveal that the person writing them is, to an extent, changed by doing the research" (p. 156). Doing this study has been a learning journey for me.

The first insight concerns my awareness of the dilemmas of doing research. My motivation for doing this research was that I believed that using everyday experiences had the potential to change the learning and teaching of secondary mathematics in Malawi. By involving teachers and students in the actual classroom context, and by personally participating in teaching sessions, I believed that I could stimulate students and teachers to think about mathematics differently, to make connections between school mathematics and everyday life. As discussed previously, very little change was achieved. Carrying out this study has highlighted for me the dilemma in expecting teachers and students to change their curriculum practice when their society expects them to fulfil the schooling requirements which define their core activity and presence in schools.

Consequently, in my role as a change agent, I was torn between two opposing worlds: the transformative and the reproductive. This dilemma is articulated in Berlak and Berlak (1981) who state that the primary function of schooling is to
transmit the culture and the society to the young. The responsibility of teachers, the reasons they are hired and paid, is to exert control over students' lives. Teachers as agents of society insure the continuity of society and culture, by imprinting on children views which are taken for granted and which were imprinted upon them through schooling and other social institutions. (p. 24)

While I wanted students to be more critical and reflective in their learning, to question and become more conscious about their curriculum realities, their teachers were expected to assume a reproductive role, to ensure that students passed their national examinations. Teachers had a professional obligation to ensure that they taught, and that their students covered the mathematics syllabus and performed well in their examinations. The teachers (and I, in adopting the role of the teacher) were torn between teaching to cover the content and teaching for understanding and connection to everyday experiences.

The two aims, transformation and reproduction, are contradictory, yet they are inevitable components of teaching and of any attempt to reform mathematics education. In my research journey, I gained more awareness of this dilemma and the inevitable consequence of needing to work with this dilemma.

In an attempt to answer the fundamental question: “what are the significant products of research in mathematics education?”, Mason (1998) has made two fundamental propositions relevant to my research journey and the participants. Firstly, Mason (1998) proposes that “the most significant products are the transformations in the being of the researchers” (p. 357, emphasis in original). This proposition also applies to teachers as researchers in their own classrooms. According to Mason, the “being” implied here involves a manifestation of “situational insight” rather than book-knowledge, and an awareness that teachers are, as reflective humans, “able to choose rather than react automatically to a situation” (p. 371). It is quite possible that, due to institutional constraints, the teachers (e.g. TD2) involved in this research would find it difficult to implement the knowledge they gained from their participation in this research. The fact that teachers considered teaching mathematics using everyday experience as a worthwhile approach is of significance here. This awareness is more likely to remain part of their body of practical knowledge about teaching, not the knowledge which can be recalled and unproblematically implemented when needed, but that which can be used as a stimulus for examining and critiquing the efficacy of assuming transmissive and culturally insensitive approaches to mathematics teaching.

As the second most significant research product, Mason (1998) proposes the “stimuli to other researchers and teachers to test out conjectures for themselves in their
own context” (p. 357, emphasis in original). The teachers in this study were able to experiment and put into practice teaching methods that accommodate everyday experience. Consequently, they gained a heightened awareness of their teaching roles and the value of linking school mathematics with everyday experience. By sharing teachers’ and students’ experiences and reflections about working in this way, this study gained valuable insights about the possibilities for and constraints to change. The research is likely to have provided teachers with a realistic “vision” for change in mathematics teaching without ignoring the problems of practice and survival, which face all teachers.

In their discussion about the type of resources needed for effecting educational change, Black and Atkin (1996) have concluded that

The resources that matter are mainly human. Are there enough willing and capable people to transform your idea into real action? If there are not, then it is not worth going further. (pp. 192-193)

In spite of the overwhelming conditions in their classrooms, the teachers and students in this study offered their time and energy to test my ideas in the real classroom. They shared their experiences, vision and constraints of what is possible to change in Malawi and how mathematics educators need to intervene with the real context in order to achieve effective student learning.

8.9 Concluding statement

Most of the students in this study did not appear to be alienated by or have an “estranged relationship” (Powell & Hoffman, 1990) with mathematics. Their lack of success in mathematics did not appear to dissuade them from believing that mathematics was interesting, useful and important to learn. However, due to their socialisation in their everyday lives, students seem to have accepted mathematics as a given entity and “enabling” tool for their active participation in society, even if the same society that universalises their perception of mathematics rejects them when they fail it. What the students in this study appeared to be estranged from is the method of teaching. This is succinctly captured in the following humble but thought provoking remark.

Mathematics was one of my best subjects in the [beginning] of my school career. I enjoyed it very much and I tried my best to get [it] right since standard 6. But now it became my enemy and now I see if possible, I give up. Everything ... goes because of method of teaching .... Learning mathematics by this time I get nothing, I [am] just wasting my time for nothing, like a mangy dog fighting for a bare bone. But I can’t do [otherwise]. I am going to [force] myself, maybe I can catch my teacher’s method. (S2LEA054)

This strongly indicates that the main reason why many students perform poorly in mathematics, and consequently, characterise themselves as mangy dogs (that
is, mathematically starved beings) struggling for a bare bone (that is, unjustifiably hard and contextually insensitive mathematics), may not be due to the nature of the discipline itself, but due to the ways in which the students are initiated into the methods of knowing the possibilities for relevance, meaning, active participation and liberation afforded through the discipline of mathematics. This therefore interrogates the way mathematics is taught. In this connection, Bishop (1992) makes a fundamental point when he proposes that as a significant teaching principle, teachers need to:

Choose appropriate contexts. Even if content is specified by the intended curriculum, the context is open to decision and choice. Teachers have the opportunity to get away from the meaningless and arbitrary contexts in mathematics questions, and to develop more meaningful and relevant contexts from today's pluralistic societies. (p. 178, emphasis in original)

Having used everyday experiences as a vehicle for changing and investigating change in mathematics learning and teaching, and having adopted a teaching role and involved teachers and students in their real contexts, I believed this could make a difference to the way teachers taught, what and how students learned and why. The students and teachers in this study saw, in a small way, the potential lying in the dialogue between school mathematics and everyday reality. Through my interaction with the actual teaching context, this study has shown the possibilities for and the constraints to achieving change through the use of everyday experiences in poorly resourced educational settings, which are populated with potentially eager consumers of culturally and socio-politically sensitive mathematics education. This made the thesis journey a significant contribution.
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APPENDIX 1

Plain Language Statement & Consent Form for Teachers

DEAKIN UNIVERSITY ETHICS COMMITTEE
PLAIN LANGUAGE STATEMENT (FOR TEACHERS)

Project title:

Using everyday experiences in teaching secondary mathematics: A case study of change in student learning in Malawian schools.

I, Willy Mwakapenda, am enrolled as a PhD student at Deakin University, Australia under the supervision of Associate Professor Susie Groves. I would like to invite you to be one of the participants to be involved in my research project, and to work with other teachers in improving the learning of mathematics. The aim of my research study is to investigate the effects on student learning and teachers' beliefs and practices when teaching approaches which link mathematics to everyday experiences are used. This study is important because it seeks to explore ways of improving the learning of mathematics. I plan to work with a group of teachers who are willing to teach mathematics in their classrooms by using everyday experiences and monitoring the effects of these approaches on how students learn mathematics. As an example of using everyday experiences, teachers and myself may decide to collect information about average monthly rainfall in their district over a certain period. We may then consider ways of using this information in planning some of the lessons or developing mathematics exercises for our students. We would then use such plans in our classes and observe students as they participate in these activities during maths lessons. Occasionally, photographs of the activities in which students will be engaged will be taken. The aim of doing this would be to see what improvements these activities bring to students' learning.

The project will last for 20 weeks and involve some additional time commitment. As part of the research, weekly meetings will be arranged by the teachers and myself where we participate in making plans of mathematics activities to be used in lessons. These meetings will also be an opportunity for us to discuss our experiences after having used these activities in our classrooms. All weekly meetings will be one-hour long and will take place in school settings. These meetings will be tape recorded. At the end of the project, teachers will be interviewed to find out their feelings about the activities of the project. The interviews will take at most 40 minutes, and will be tape recorded.

At both the beginning and end of the study, students will complete a short questionnaire to find out their views about learning mathematics, and how these views have changed over the course of the project. At the end of the study, you will be asked to interview students from my class, and I will interview students from your class. The interviews will be 30 minutes long and will be tape recorded.

All data collected in this study will be kept confidential and used for research purposes only. No names or personal details of participants will be revealed in my report of the project. The full report will not be circulated to participants. However, I will provide a brief summary of the research findings when the project finishes.

The results of the research may be reported in future conferences or journal papers, but anonymity of participants will be strictly adhered to.

If you agree to participate in this project, you will be free to withdraw your consent at any time during the study. If that happens, your participation in this study will immediately cease and any information obtained from you will not be used.

I expect that the experiences gained by you will be enjoyable and beneficial. This project is seen as part of the professional development of teachers involved, and should form an innovative and practical aspect of teaching and students' learning.

If you require further information about this study, please contact the researcher or the supervisor on the following telephone numbers:

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DEAKIN UNIVERSITY ETHICS COMMITTEE
CONSENT FORM (FOR TEACHERS)

I,

Hereby consent to be a subject of a human research study to be undertaken
by Willy W.J. Mwakapenda

and I understand that the purpose of the research is to investigate the effects of using everyday experiences in the learning of mathematics in Malawian schools.

I acknowledge

1. That the aims, methods, and anticipated benefits, and possible hazards of the research study, have been explained to me.

2. That I voluntarily and freely give my consent to my participation in such research study.

3. I understand that results will be used for research purposes and may be reported in scientific and academic journals.

4. Individual results will not be released to any person except at my request and on my authorisation.

5. That I am free to withdraw my consent at any time during the study, in which case my participation in the research study will immediately cease and any information obtained from me will not be used.

Signature:

Date:
Classroom setting at the Distance Education Centre (DEC)
APPENDIX 3

Classroom setting at the Secondary School (SEC)
The first student questionnaire

The aim of this questionnaire is to find out students' ideas and feelings about mathematics. Your honest responses to these questions will be appreciated.

1. *Which of the following is closest to how you feel about mathematics?*
   (a) very interesting    (b) interesting    (c) boring    (d) very boring
   (Please circle one)
   Give reasons for your choice

2. *Do you think learning mathematics is important? Please, give reasons for your answer.*

3. *How would you like mathematics to be changed in order to make it more interesting for you?*


Please feel free to add more information about what you have said above (You can also use the other side of this page)

Thank you
### Examples of teaching plans made for some topics

<table>
<thead>
<tr>
<th>Topic</th>
<th>School &amp; Year Level</th>
<th>Activities &amp; discussions planned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Form</td>
<td>DEC, Form 2</td>
<td>Discuss why we need to express numbers in standard form. Who does this in real life? Show students a similar example of use of standard form in real life. For example, in a newspaper report K3,000,000 is written as K3 million.</td>
</tr>
<tr>
<td>Logarithms</td>
<td>DEC, Form 2</td>
<td>Discuss why it is necessary to learn about logarithms. Why should we use logarithm tables? The syllabus suggests that logarithms are used when performing computations involving large numbers. Discuss where large numbers come from, e.g., show students examples of items with bar codes.</td>
</tr>
<tr>
<td>Use of Four-figure Tables</td>
<td>DEC, Form 2, SEC, Form 2</td>
<td>To discuss the following questions with students: Why learn about use of tables? Where in everyday life do people use these tables? Discuss similar examples of &quot;tables&quot; used in everyday life, for example, a table of bus fares used by a bus conductor. In one lesson, let students use calculators instead of tables. Discuss when it may be better to use a calculator than a four-figure table.</td>
</tr>
<tr>
<td>Direct &amp; Inverse Proportions</td>
<td>SEC, Form 2</td>
<td>Ask students to give examples of everyday situations involving Direct &amp; Inverse Proportions, for example, food consumed vs population of students. Ask students to estimate their walking speeds &amp; test their predictions in a practical activity.</td>
</tr>
<tr>
<td>Averages</td>
<td>SEC, Form 2</td>
<td>Use data from students about their shoe sizes, their ages. Give students a multiple choice exercise to assess their understanding of the concept of average.</td>
</tr>
<tr>
<td>Bearings</td>
<td>SEC, Form 4</td>
<td>Discuss the use of sun sets and sun rises as a way of identifying compass directions (e.g., which direction is the North?) Discuss why their classes are denoted as Form 4 North, 4 West, etc.</td>
</tr>
<tr>
<td>Arithmetic Progressions</td>
<td>SEC, Form 4</td>
<td>Ask students to give examples of everyday situations in which we can identify sequences e.g., 1, 2, 3, 4, ... [For example, layers of bricks in a part of the brick wall of their school block.]</td>
</tr>
<tr>
<td>Probability</td>
<td>SEC, Form 4</td>
<td>Discuss examples of events in real life when probability of their occurrence is not half. [For example, the probability of a boy being born. This should lead to a discussion about why, according to the 1995 Census statistics, there are more females than males in Malawi.]</td>
</tr>
</tbody>
</table>
Appendix 6

An example of discussion points for a lesson on Probability

(Discussed with teacher TS4)

Topic: Probability Year level: Form 4 Date: 7/8/97

Aims of the lesson:
a) to describe everyday situations which could enable students to build a meaningful understanding and application of the concept of probability
b) to enable students to estimate probabilities of events.

In the topic of probability, the examination syllabus requires students to “find the probability of a single event”. However, there are no guidelines in the syllabus about how the teacher could proceed to teach the topic.

Some teaching suggestions
In order to introduce the concept of probability, we could try to get students to give examples of everyday situations in which people talk about “chance”, that is, the chance of something happening. Here we could recall a time when their school had a “Top of the Class Oral Quiz Competition” with another school. [The competition involves 8 best students, 4 from each school]. Students would recall that the Quizmaster always says: “Which team would like to start? Heads or tails?” In order to decide which team starts, the Quizmaster tosses a coin. Students will probably say that sometimes the team which chooses “Heads” does not start first.

We could get students to simulate the Quiz Competition. We could arrange a group of four students, one of them would be the “Quizmaster”, the other two would be team members, and the fourth would be the scoremaster/mistress. We could ask the “Quizmaster” to toss the coin a number of times (say 10). The scoremaster would record how many heads and tails they get.

Then we could introduce terms such as:
a) Outcome, that is, the result of our experiment (eg head or tail);
b) event, that is, the outcome we are interested in (eg a head); and
c) the chance that an event happens, that is, the fraction or ratio of the number of times our event happens to the total number of outcomes [ie. number of heads divided by the total number of heads and tails].

Next, we could ask students what they think is the “chance that you get a head when you toss a coin”. Some would say 50-50, which is the same as 1/2 or 50/(50+50). The we could compare this prediction with the results we get from performing the experiment. A discussion of this could lead us to an elaboration of the terms “bias”, “fair coin”. We could ask them to comment on the “fairness” of using the coin-tossing strategy for determining which team starts during the Top of the Class Quiz Competition ...

As another activity, we could ask students the following question: “Recall a situation when one of your female relatives had been expectant. Did you think they were going to have a baby boy or baby girl? What finally happened? What can you say about the chance that the baby born will be a girl, for example?”

Here, we may expect students to say that the chance is 1/2.

As an extension, we could collect information from students about the total number of sisters and brothers born in their family. From this information, we could find out whether there are more girls being born than boys. We could then compare this information with the data from the National Statistics Office of Malawi which shows that there are more females than males in Malawi. We could then discuss why this is the case, and whether it is the same in other countries.
APPENDIX 7

Classroom Observation Schedule

IDNO:
Date:
Participant No:
Year Level:
No. of Students:

School:
Observation No:
Duration:
Lesson Topic:

PHYSICAL SETTING

RESOURCES USED

Topic Outline

Everyday Examples used:
# Classroom Observation Sheet

**ID NO.:**  
**LESSON No.:**  
**DATE**  
**Page: 2**

**Participant's Name:**  
**Form (Grade):**  
**School:**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
<th>Comments</th>
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</tbody>
</table>
The Final Student Questionnaire

The aim of this questionnaire is to find out students' ideas and feelings about mathematics. Your honest responses to these questions will be appreciated.

1 Which of the following is closest to how you feel about mathematics now? 
(Masamu mukuona hwani panopa?)
(a) very interesting  (b) interesting  (c) boring  (d) very boring
(Please circle one)
Give reasons for your choice (Pelekani zifukwa zake)

2 Do you think learning mathematics is important? Please, give reasons for your answer.
(Kuphunzira masamu ndikufunika? Tchulani zifukwa zake)

3 How do you feel about how you have been learning mathematics this year? 
Explain. (Mukuona hwani mmene mumaphunzirira masantu chaka chino? Pali kusintha kwina kuli konse kapena iyai? Fotokozani.)

4 When learning mathematics this year, what things did you like most? 
Explain. (Pophunzira masamu chaka chino, pali zina zimene mwasangalala nazo kwambiri? Fotokozani mwachidule).

5 What things did you like least? Why? 
(Pali zina zimene sizenakusangalaiseni? Fotokozani).

Please feel free to add more information about what you have said above. 
(Ngati muli ndi zonena zina, tanenani. Mukhoza kulembanso kuseri kwa pepala ili).

Thank you. (Zikomo kwambiri. Tasangalala kukhala nanu)
APPENDIX 9

Teachers’ Interview Schedule

Item 1: Background information
What are your educational qualifications?
How long have you been teaching at primary / junior secondary / senior secondary level? ie. Standard 1 to 8 / form 1 or 2 / form 3 or 4?
How many years have you taught mathematics at this level?
How long have you been teaching at this school?
How long have you been teaching altogether?
What other subjects do you teach?
What size(s) is (are) your class(es)?

Item 2: Teacher’s perceptions of their mathematics teaching:
What has been the major characteristics of your mathematics teaching this year?
How did you organise your teaching in the classroom?
whole class, group work, individual seatwork, textbooks and other resources...
Could you describe what happened in a typical mathematics lesson?
How do you see the teacher’s role in such a lesson?
What would you expect the students to be doing?
Could you describe the sort of planning you did for your maths teaching?
Covering the syllabus, problem-solving exercises, checking examination guides,...
How did you decide on the learning activities to be included in your maths lessons?
What did you consider?
How did you ensure that the activities are relevant and appropriate?
How did you ensure participation of all students?
What do you see as the strongest arguments for your approach to maths teaching?
Is your teaching based on any theory or general idea about teaching?
Please explain and give examples which apply to your situation.
Do you see any arguments against your approach to maths teaching?

Item 3: Changes in teaching
How has your thinking on teaching maths changed over the course of the project?
What have you personally gained from your participation in the project?
What obstacles do you feel prevented you from fully achieving your goals?
How did you attempt to overcome them?
What changes do you intend making in the way you are teaching maths now?
What advice would you give to other teachers?

Item 4: Effects on students
What effect do you think this type of teaching has on the students’ learning?
Students’ participation in mathematics
More active, more discussions about mathematics, more questioning...
Have you observed these effects in your own classroom?
Please give specific examples.
How has students’ learning been affected by these activities?
Please explain.
What has been the most significant change in the students which you have taught over the course of the project? Please explain.

Before we conclude, could you summarise the most important points in what you have said. Is there anything else related to your mathematics teaching that you want to tell me?

Thank you.
An example of a completed first student questionnaire

The aim of this questionnaire is to find out students' ideas and feelings about mathematics. Your honest and detailed responses to these questions will be appreciated.

1. Which of the following is closest to how you feel about mathematics?
   (a) very interesting   (b) interesting   (c) boring   (d) very boring
   (please circle one)
   Give reasons for your choice
   The way numbers and letters are used in Mathematics give interest in the sense that things which seem impossible do exist in Mathematics. Example: taking a 1 from 0 to give -1.

2. Do you think learning mathematics is important? Please, give reasons for your answer.
   Indeed, it's an importance. Students who do well in Maths are always bright in class. It seems that Mathematicians do reason out very quickly at Very Activity. When there's an advertisement, Maths is the first subject to be taken into account.

3. How would you like mathematics to be changed in order to make it more interesting for you?
   Algebra and Geometry have to be introduced in Primary schools, so that when doing Secondary level education, we need to have few topics to be covered. Method of teaching has to be watched over. A teacher is very crucial, then students do not comprehend the teaching.

4. What factors do you think contribute to the difficulty of mathematics? Please explain.
   The laziness of students by not practising or asking the difficulty arises in Maths to teachers responsible. Method and techniques of teaching. Lack of good materials. Self-shame within teachers and students.

Please feel free to add more information about what you have said above (You can also use the other side of this page).

Thank you.
<table>
<thead>
<tr>
<th>Question 1</th>
<th>Question 2</th>
<th>Question 3</th>
<th>Question 4</th>
<th>Additional comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which of the following is closest to how you feel about mathematics? (a) very interesting (b) interesting (c) boring (d) very boring. Give reasons.</td>
<td>Do you think learning mathematics is important?</td>
<td>How would you like maths to be changed in order to make it more interesting for you?</td>
<td>What factors contribute to the difficulty of maths? Please explain.</td>
<td></td>
</tr>
<tr>
<td>S4QA001</td>
<td>b the way numbers and letters are used in maths gives interest in the sense that things which seem impossible do exist in maths. Example taking a 1 from 0 to give -1</td>
<td>Indeed it's of importance... When there is an advertisement, maths is the first subject to be taken into account</td>
<td>Algebra &amp; geometry have to be introduced in primary schools... The method of teaching has to be watched out. If the teacher is very cruel, then students do not comprehend the teaching</td>
<td>The laziness of students by not practicing... selfishness within teachers and students</td>
</tr>
<tr>
<td>S4QA002</td>
<td>b maths proves some truths which cannot be done practically. It also gives the brain the business of learning to think more</td>
<td>Job opportunities you cannot be employed with a failure in it. If you cannot go for further education One cannot be interviewed at a university</td>
<td>Know the problems of the students</td>
<td>Teacher should give problems which suit with the example given</td>
</tr>
<tr>
<td>S4QA003</td>
<td>b helps one to strengthen their brain because it needs a lot of thinking</td>
<td>High chance of getting a job calculations</td>
<td>Questions &amp; straightforward practice</td>
<td>Ambiguous methods, long methods</td>
</tr>
<tr>
<td>S4QA004</td>
<td>b with maths we just solve sums on our own, not spending time studying what one wrote in books</td>
<td>Used in everyday life, business</td>
<td>Teachers must not rush when teaching</td>
<td>Teachers rush to finish the syllabus books</td>
</tr>
<tr>
<td>S4QA005</td>
<td>b has benefits to everyday life. Maths has more to do in this technological world</td>
<td>The world we are living in is a complex one and to get anything from it, one must rise above the system. The world of technology needs maths to function well</td>
<td>Putting maths in a vernacular language can worsen the process but just simplify the original one (English)</td>
<td>Students in Malawi are taking more subjects than those abroad, relieve this burden from the students of today</td>
</tr>
<tr>
<td>S4QA006</td>
<td>b shows one's intelligence because to know maths is not a joke</td>
<td>Increases thinking capacity because to solve a mathematical problem it needs brain racking</td>
<td>Examples given are simple but exams are difficult change this system remember to be patient as well when teaching!!</td>
<td></td>
</tr>
<tr>
<td>S4QA007</td>
<td>b it refreshes the brain whenever there is fatigue after studying for too long. It enlightens the thinking capability. That's why I like it</td>
<td>Impacts/applications on everyday life, bricklaying</td>
<td>It would be interesting for me when teachers give a lot more problems to students, and explain wherever possible the ways to arrive at the answer required without actually spoon feeding</td>
<td>The maths problems given are not worth the knowledge we have, thus we keep on failing because they usually seem strange to us. There is need to start a foundation when building a house. We need to be given soft problems first</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Students enjoy maths most when they have a clear background. Besides that maths seems very difficult but that's not the case. There is need to soften the brain we have then harden later. We fail maths because of poor background, that much I know. I tend to wonder if we are not capable of matching with those who pass maths with distinctions, does it mean that we are all ignorant? No, that's not.</td>
</tr>
</tbody>
</table>
APPENDIX 12

Notes made during the analysis of questionnaire responses

Dear [Name],

I am writing to you today to discuss the results of our recent questionnaire survey. As you may recall, the survey was conducted to gather feedback on our teaching methods and improve our curriculum. I wanted to share some of the insights we've gained from analyzing the responses.

1. Many students mentioned that they felt more engaged when the class was interactive and included hands-on activities. How can we incorporate more of these types of activities into our lessons?

2. Several students expressed that they felt less stressed when they had more opportunities to participate in class discussions. Is there a way we can allow more students to share their thoughts and ideas?

3. Some students noted that they preferred to work in groups, while others preferred to work alone. How can we design our classes to accommodate both preferences?

4. Many students commented on the importance of feedback. How can we ensure that our feedback is constructive and helpful?

5. Some students felt that they needed more resources to succeed in the course. Are there any resources that we can provide to help them?

6. Many students expressed that they enjoyed the variety of teaching methods used in class. How can we maintain this variety while also focusing on specific learning objectives?

7. Some students mentioned that they valued the opportunity to learn at their own pace. How can we provide more personalized learning opportunities?

8. Many students commented on the importance of clear and concise explanations. How can we improve our teaching style to make the material more accessible?

9. Some students expressed that they felt more motivated when they understood the relevance of the course material to their lives. How can we connect the material to real-world applications?

10. Many students mentioned that they felt more comfortable asking questions when they knew they would not be judged. How can we create a classroom environment where students feel safe to ask questions and make mistakes?

Please let me know if you have any further comments or suggestions. I look forward to hearing from you.

Best regards,

[Your Name]
APPENDIX 14

Percentages of students for each response category for all questions in the first questionnaire

Students' views of mathematics (Q1A First)

<table>
<thead>
<tr>
<th>Response Category</th>
<th>Form 2 DEC First: N=165</th>
<th>Form 2 SEC First: N=54</th>
<th>Form 4 SEC First: N=126</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Very Interesting</td>
<td>78</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>Interesting</td>
<td>86</td>
<td>44</td>
<td>25</td>
</tr>
<tr>
<td>Boring</td>
<td>13</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Very Boring</td>
<td>16</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Undecided</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>195</td>
<td>100</td>
<td>54</td>
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</tbody>
</table>

Reasons for finding mathematics interesting (Q1B First)

<table>
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<tr>
<th>Response Category</th>
<th>Form 2 DEC First: N=164</th>
<th>Form 2 SEC First: N=53</th>
<th>Form 4 SEC First: N=104</th>
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<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Successful (SU)</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Partially Successful (PS)</td>
<td>31</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>Good Teaching (GT)</td>
<td>5</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Gain Knowledge (GK)</td>
<td>8</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Utility of Mathematics (UM)</td>
<td>62</td>
<td>38</td>
<td>6</td>
</tr>
<tr>
<td>Promotes Thinking (PT)</td>
<td>16</td>
<td>10</td>
<td>10</td>
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<tr>
<td>Nature of Mathematics (NM)</td>
<td>8</td>
<td>5</td>
<td>3</td>
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<tr>
<td>Enjoy doing Maths (EM)</td>
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<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Interested but Not successful (IN)</td>
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<td>7</td>
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<tr>
<td><strong>Total</strong></td>
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</table>
### Reasons for not finding mathematics interesting (Q1B First)

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<th>Form 4 SEC First: N=18</th>
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<tbody>
<tr>
<td>Not successful (NS)</td>
<td>9</td>
<td>4</td>
<td>14</td>
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<tr>
<td>Partially successful (PS)</td>
<td>3</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Poor Teaching (PT)</td>
<td>12</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Nature of Mathematics (NM)</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Limited Resources (LR)</td>
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<tr>
<td>Other (OT)</td>
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<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>10</td>
<td>21</td>
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</table>

### Reasons given for the importance of learning mathematics (Q2 First)

<table>
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<th>Form 4 SEC First: N=126</th>
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<tbody>
<tr>
<td>Promotes thinking (PT)</td>
<td>23</td>
<td>15</td>
<td>19</td>
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<tr>
<td>Gain Knowledge (GK)</td>
<td>30</td>
<td>1</td>
<td>10</td>
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<tr>
<td>Use in Other subjects (UO)</td>
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<td>3</td>
<td>6</td>
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<tr>
<td>Further Education (FE)</td>
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<td>Job Opportunities (JO)</td>
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<td>Business Use (BU)</td>
<td>16</td>
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<td>19</td>
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<tr>
<td>Use at Work (UW)</td>
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<td>23</td>
<td>53</td>
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<tr>
<td>Partially Important (PI)</td>
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<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Not Important (NI)</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>210</td>
<td>82</td>
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</table>
How mathematics could be changed to make it more interesting (Q3 First)

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<th>Form 2 SEC First: N=54</th>
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<th>Form 4 SEC First: N=126</th>
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<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Change Teaching (CT)</td>
<td>42</td>
<td>22</td>
<td>18</td>
<td>33</td>
<td>38</td>
<td>30</td>
</tr>
<tr>
<td>Adequate teacher Training (AT)</td>
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<td>1</td>
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<tr>
<td>Change Content (CC)</td>
<td>28</td>
<td>14</td>
<td>10</td>
<td>19</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Change Language (CL)</td>
<td>12</td>
<td>6</td>
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<td>Choose Branch (CB)</td>
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<td>1</td>
<td>2</td>
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<td>6</td>
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<tr>
<td>Change Assessment (CA)</td>
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<td>1</td>
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<td>Frequent Testing (FT)</td>
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<td>3</td>
<td>6</td>
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</tr>
<tr>
<td>More Teachers (MT)</td>
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<td>5</td>
<td>8</td>
<td>15</td>
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<tr>
<td>Increase Learning Resources (LR)</td>
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<td>9</td>
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<tr>
<td>More Group Work (GW)</td>
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<td>0</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Regular Practice (RP)</td>
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<td>4</td>
<td>6</td>
<td>11</td>
<td>19</td>
<td>15</td>
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<tr>
<td>Just Change (JC)</td>
<td>15</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>6</td>
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<tr>
<td>do Not Change (NC)</td>
<td>15</td>
<td>8</td>
<td>5</td>
<td>9</td>
<td>10</td>
<td>8</td>
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<tr>
<td><strong>Total</strong></td>
<td>153</td>
<td>80</td>
<td>56</td>
<td>104</td>
<td>129</td>
<td>105</td>
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</tbody>
</table>

Factors contributing to the difficulty of mathematics (Q4 First)

<table>
<thead>
<tr>
<th>Response Category</th>
<th>Form 2 DEC First: N=195</th>
<th></th>
<th>Form 2 SEC First: N=54</th>
<th></th>
<th>Form 4 SEC First: N=126</th>
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<tr>
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<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Teaching style (TS)</td>
<td>25</td>
<td>13</td>
<td>14</td>
<td>26</td>
<td>23</td>
<td>18</td>
</tr>
<tr>
<td>Poor teacher Training (PT)</td>
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<td>10</td>
<td>1</td>
<td>2</td>
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<tr>
<td>Teacher Effort (TE)</td>
<td>28</td>
<td>14</td>
<td>10</td>
<td>19</td>
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<td>Nature of Mathematics (NM)</td>
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<td>1</td>
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<td>Difficult Topics (DT)</td>
<td>21</td>
<td>11</td>
<td>4</td>
<td>7</td>
<td>12</td>
<td>10</td>
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<tr>
<td>Assessment Style (AS)</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>7</td>
<td>23</td>
<td>18</td>
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<tr>
<td>Insufficient Practice (IP)</td>
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<td>5</td>
<td>14</td>
<td>26</td>
<td>33</td>
<td>26</td>
</tr>
<tr>
<td>Insufficient learning Materials (IM)</td>
<td>31</td>
<td>16</td>
<td>6</td>
<td>11</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Insufficient learning Time (IT)</td>
<td>17</td>
<td>9</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Shortage of Teachers (ST)</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>6</td>
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<td>0</td>
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<tr>
<td>English Language (EL)</td>
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<td>2</td>
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<tr>
<td>Other (OT)</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>8</td>
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<tr>
<td><strong>Total</strong></td>
<td>173</td>
<td>94</td>
<td>60</td>
<td>112</td>
<td>113</td>
<td>91</td>
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</tbody>
</table>
## Aspects students liked least in learning mathematics (Q5 Final)

<table>
<thead>
<tr>
<th>Response Category</th>
<th>Form 2 DEC Final: N=81</th>
<th></th>
<th>Form 2 SEC Final: N=152</th>
<th></th>
<th>Form 4 SEC Final: N=79</th>
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<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Specific Topics (ST)</td>
<td>27</td>
<td>33</td>
<td>72</td>
<td>47</td>
<td>31</td>
<td>39</td>
</tr>
<tr>
<td>Not Finishing Syllabus (NF)</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Too Much Content (MC)</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Assessment Style (AS)</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>7</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Forced Participation (FP)</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Being Fired with Questions (FO)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
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</tr>
<tr>
<td>Teaching Pace (TP)</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Learning in Afternoon (LA)</td>
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<td>0</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Students Making Noise (MN)</td>
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<td>7</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Research Journal (RJ)</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Insufficient Learning Time (IT)</td>
<td>6</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Insufficient Learning Materials (IM)</td>
<td>6</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Nothing (NO)</td>
<td>17</td>
<td>21</td>
<td>19</td>
<td>12</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>45</td>
<td>78</td>
<td>114</td>
<td>78</td>
<td>70</td>
<td>88</td>
</tr>
<tr>
<td>S4QAO 23</td>
<td>X b. because we solve the diagram which are not real and at the end we find that they are the same</td>
<td>learning maths has no importance because nowadays most of the work is done by computer in the offices. Here in Malawi, students are not given chance to choose subject which they want according to their work [plants] in the future</td>
<td>laziness of the student</td>
<td>X CB b. learning maths should not be compulsory. Those who feel that maths is an interesting subject, they should continue learning in order to improve science. You can't force someone to do a thing which he/she doesn't want. As a result, he/she will not succeed in the future S4QAO23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>---------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>---------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4QAO 24</td>
<td>X b encourages our brain to work normally and faster. As far as mathematics is concerned it is a difficult subject which I wouldn't prefer to get good marks</td>
<td>can't find a job without maths to be an accountant needs to pass maths but I can't do it since I'm not good at maths</td>
<td>poor background</td>
<td>possibly we can say that it's boring because I don't know what I'm doing about it because I just fail maths</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4QAO 25</td>
<td>X b. mathematics is the only subject which shows that one knows what she is doing and as you do it you enjoy it.</td>
<td>needs total concentration of the brain</td>
<td>having a negative attitude towards maths is very bad. It has been said as far as I can remember that maths is tough. With that in mind one finds it really tough</td>
<td>X practising maths needs to be a habit. If one is used to it we will all be good mathematicians. Pupils be encouraged to participate in maths even though they find it hard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4QAO 26</td>
<td>X b. I like only two branches</td>
<td>how to calculate things</td>
<td>be given chance to ask</td>
<td>students do not understand the example or exercise which their teacher has given. Student are given exercise which is opposite to the example</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4QAO 27</td>
<td>X b. because it's the only way I can know how to calculate and when it comes to work such as papering and road contrator you may apply mathematics knowledge particularly geometry (angles and adjacent)</td>
<td>it can help to maintain memory in the brain and you can't work without maths</td>
<td>X LM b. I wish those publishers of books should publish more model-answer books which students may work out a problem then check it to the given answer. If it is correct, in this way it can encourage students in maths who study on their own at home S4QAO27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4QAO 28</td>
<td>X a. helps me to think</td>
<td>one time will be responsible for our families budget</td>
<td>frequent maths test group work</td>
<td>we are very lazy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4QAO 29</td>
<td>X a. it is a very interesting subject because once a problem is solved it becomes easy for it to be checked and arrive at the same problem again</td>
<td>to run business helps engineers helps in security in algebra those who have not learned it cannot understand some of the information present in it</td>
<td>by going on discovering new methods of simplifying mathematical problems</td>
<td>teacher's presentation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

APPENDIX 15

Selected excerpts ("X") from questionnaire data

| S4QAO 23 | X b. because we solve the diagram which are not real and at the end we find that they are the same | learning maths has no importance because nowadays most of the work is done by computer in the offices. Here in Malawi, students are not given chance to choose subject which they want according to their work [plants] in the future | laziness of the student | X CB b. learning maths should not be compulsory. Those who feel that maths is an interesting subject, they should continue learning in order to improve science. You can't force someone to do a thing which he/she doesn't want. As a result, he/she will not succeed in the future S4QAO23 |
| S4QAO 24 | X b encourages our brain to work normally and faster. As far as mathematics is concerned it is a difficult subject which I wouldn't prefer to get good marks | can't find a job without maths to be an accountant needs to pass maths but I can't do it since I'm not good at maths | poor background | possibly we can say that it's boring because I don't know what I'm doing about it because I just fail maths |
| S4QAO 25 | X b. mathematics is the only subject which shows that one knows what she is doing and as you do it you enjoy it. | needs total concentration of the brain | having a negative attitude towards maths is very bad. It has been said as far as I can remember that maths is tough. With that in mind one finds it really tough | X practising maths needs to be a habit. If one is used to it we will all be good mathematicians. Pupils be encouraged to participate in maths even though they find it hard |
| S4QAO 26 | X b. I like only two branches | how to calculate things | be given chance to ask | students do not understand the example or exercise which their teacher has given. Student are given exercise which is opposite to the example |
| S4QAO 27 | X b. because it's the only way I can know how to calculate and when it comes to work such as papering and road contrator you may apply mathematics knowledge particularly geometry (angles and adjacent) | it can help to maintain memory in the brain and you can't work without maths | X LM b. I wish those publishers of books should publish more model-answer books which students may work out a problem then check it to the given answer. If it is correct, in this way it can encourage students in maths who study on their own at home S4QAO27 |
| S4QAO 28 | X a. helps me to think | one time will be responsible for our families budget | frequent maths test group work | we are very lazy |
| S4QAO 29 | X a. it is a very interesting subject because once a problem is solved it becomes easy for it to be checked and arrive at the same problem again | to run business helps engineers helps in security in algebra those who have not learned it cannot understand some of the information present in it | by going on discovering new methods of simplifying mathematical problems | teacher's presentation |
APPENDIX 16

Examples of completed observation schedules

CLASSROOM OBSERVATION SCHEDULE

IDNO: 8  
Date: 27/5/92  
School: SEC  
Observation No: 8  
Duration: 80 min.

Teacher:  
Year Level: 4W (Reform)  
Lesson Topic: Geometrical Construction

No. of Students: ~98  
Observer: T54

PHYSICAL SETTING

Normal classroom setting (i.e 8 rows, 6 pupils per row)

RESOURCES USED

- Compasses
- Ruler
- Protractor
- Pencils
- Chalk
- Eraser

Topic Outline:

Teaching: Constructions (written on the board). The question was written on the board.

Introduction: laying out g. The steps followed in construction, sketching of the information construction. Pupils discuss the construction.

Everyday Examples used:
<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
<th>Comments</th>
<th>Activity Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:10</td>
<td>Heading of the lesson</td>
<td>Well written on the board (good use of the blackboard)</td>
<td>Writing</td>
</tr>
<tr>
<td>10:20</td>
<td>Question write on the board</td>
<td>Well written on the board and clearly seen at the back of the classroom</td>
<td>Writing</td>
</tr>
<tr>
<td>10:25</td>
<td>Sketching the information in the question by means of a diagram</td>
<td>Explanation on the sketch quite good</td>
<td>Explaining</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:30</td>
<td>Construction</td>
<td>Pupils were doing the construction on their own. Some pupils were not using ruler and compass, they were using free hand. Called the pupil to sit next to a teacher who knows the construction. Moved from row to row. Pupils were happy of what they have learnt.</td>
<td>Group discussion (some) Group discussion Group discussion (questioning)</td>
</tr>
<tr>
<td>11:00</td>
<td>The teacher helping a pupil to construct 120°</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CLASSROOM OBSERVATION SCHEDULE

Teacher: [Blank]
Date: 5/2/17
Year Level: 6L
No. of Students: 52
Observer: [Blank]

School: SEC
Observation No.: 33
Duration: 40 min
Lesson Topic: Averages

PHYSICAL SETTING

RESOURCES USED

Topic Outline:

Everyday Examples used:
<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What does &quot;average&quot; mean?</td>
<td>Did not get the meaning of possible.</td>
</tr>
<tr>
<td></td>
<td>If average of N numbers is say 10, it doesn't mean that all the numbers are 10.</td>
<td>May be we should indicate another option if all are correct. Since it seems that one they get one correct one they don't look at the other options.</td>
</tr>
</tbody>
</table>
CLASSROOM OBSERVATION SCHEDULE

ID NO: 45  
Date: 11-08-97  
Participant: WM (Reservist)  
Year Level: 2  
No. of Students: ~160  
Observer: TD2

PHYSICAL SETTING

RESOURCES USED

- Papers
- Set Squares

Topic Outline:

- Area
  - Rectangle
  - Triangle
  - Parallelogram

Everyday Examples used:

- Area of Rectangle e.g. Classroom area
  - (how much surface area students occupy in the classroom)

- Area of a Garden (to know how much
  fertilizer to be applied to the grass)

- Triangle not commonly used
## CLASSROOM OBSERVATION SHEET

**IDNO:** 41-7  
**Lesson No:** 4-5  
**Date:** 11/09/22  
**Page:** 2

**Participant's name:**  
(Anonymous)

<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Base of Triangle by arranging the Paper cut in form of a triangle</td>
<td>Meaningful, lively and relevant introduction to the topic.</td>
</tr>
<tr>
<td>(ii)</td>
<td>Combining two triangles which are similar to form a parallelogram</td>
<td>Direct use of everyday examples which student are familiar with.</td>
</tr>
<tr>
<td>(iii)</td>
<td>Cutting a triangle from the combined triangle and give it to the other hand to form a rectangle</td>
<td>Effective question technique, very good but were answered by boys only.</td>
</tr>
</tbody>
</table>

- Students were not organised clearly as a result few students followed what was going on.
- Sequence of points was explained clearly and if the points is important the teacher tried to repeat it.
- Participation of student to the lesson was very low due to the topic they thought they know more about it.
- Activities were enough depending on the topic.

**Form (Grade):** 2  
**School:**  

**Expected to know:**
- Weekly or daily work?
Areas need to be considered

- Involve both boys and girls
- Try to be a bit fast in order to catch them
- Do not hesitate to organise student close to the board
CLASSROOM OBSERVATION SCHEDULE

IDNO: 26  
Date: 26/8/97  
Parish/Paro: TS4  
Year Level: W4  
No. of Students: 56  
Observer: WM

School: SEE  
Observation No:  
Duration:  
Lesson Topic: 

PHYSICAL SETTING

Normal Setting

RESOURCES USED

Topic Outline:

Everyday Examples used:
- Hospital (use of thermometer)
- Students lined up to form a line (practiced)
<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
<th>Comments</th>
<th>Activity types</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>teacher called 3 boys to A, B, C front</td>
<td>+1 is boy, -1 is girl. (teacher had line with negative 1 to the left, 1 to the right.)</td>
<td></td>
</tr>
<tr>
<td>1.45</td>
<td>What class can you separate from the attentive class? [Teacher wrote 'Can be using a graph?'.] [Teacher could have asked 'Could I have asked this in a different way?']</td>
<td>Discussion: number of boys and girls.</td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td>Teacher gives a unit of directed number. We are given 3, we positive.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Teacher wrote 'Average of TAF'.]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3 < 8 / A student had problems / (maybe the problem was a negative sign?)
3 kg > 3000 g

Activity 1

(a) Identify something you would like to improve.

(b) Describe the problem.

(c) Propose a solution.

Explain:

- How can we know that we can classify this?

- How can we show that here $x > 2$.

- Explain, using only students' "do we understand" and students' "please say "yes""

- Do you see the difference? Yes.

- Any questions before I proceed. (Small positive was a bit small)

- Please lend me your peels. Don't sleep.

Q. A.

Where are you finding $x$?

Please answer the question of the day.

Perhaps, if this question is abstract, we should do with concrete examples.

- A question from more uniform.

- 3 kg used. Remainder could be enhanced.

- 251. Paper on assignment (compare with side 220)
# Classroom Observation Schedule

**Teacher:** 152  
**Date:** 11/6/97  
**Participant No:** 152  
**Year Level:** 2N  
**No. of Students:** 61  
**Course:** WM  
**School:**  
**Observation No:**  
**Duration:**  
**Lesson Topic:** Inequalities - Inequalities

<table>
<thead>
<tr>
<th>PHYSICAL SETTING</th>
<th>RESOURCES USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Classroom</td>
<td>chalk, ruler, pen</td>
</tr>
<tr>
<td>8 x 7</td>
<td></td>
</tr>
</tbody>
</table>

**Topic Outline:** Introduce graphical representation for inequalities.

**Everyday Examples used:**  
Can we find some examples of inequality signs used in daily life?
<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
<th>Comments</th>
<th>Activity types</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:10</td>
<td>2 &gt; 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 &gt; 1</td>
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<td>2 &gt; 1</td>
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<td>8:22</td>
<td>2 &gt; 1</td>
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<td>2 &gt; 1</td>
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</tr>
</tbody>
</table>

**Possible activities**

- Exposition
- Explanation
- Question
- Demonstration
- Lecture
- Student work
- Group work
- Discussion
- Assignment
- Test
- Examination
- Practice
- Problem solving
- Quiz
- Essay

**Classroom Observation Sheet**

**Participant's name: T.S.*  \*Form (Grade): 2A  \*School: SEC  \*Lesson No: 18  \*Date: 11/6/92  Page: 2**
<table>
<thead>
<tr>
<th>IDNO.</th>
<th>262</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>20/5</td>
</tr>
<tr>
<td>Teacher Name</td>
<td>TB2</td>
</tr>
<tr>
<td>Year Level</td>
<td>Enrenz</td>
</tr>
<tr>
<td>No of Students</td>
<td>515</td>
</tr>
<tr>
<td>PHYSICAL SETTING</td>
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<tr>
<td>OUTSIDE CLASSROOM</td>
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</table>

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th>DEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation Nr</td>
<td>2</td>
</tr>
<tr>
<td>Duration</td>
<td>2 (8:30 - 9:30)</td>
</tr>
<tr>
<td>Lesson Topic</td>
<td>Standard Form (Arithmetic)</td>
</tr>
</tbody>
</table>

| RESOURCES USED |

<table>
<thead>
<tr>
<th>Topic Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARD FORM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Everyday Examples used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjust using words such as:</td>
</tr>
<tr>
<td>Time</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>8:25</td>
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</tr>
</tbody>
</table>

**Additional Notes:**

- Student asked: 3.5 million k3
- Students were asked to see what was written on the board.
## APPENDIX 17a

**Summary of Reflections on Classroom Observations in TS4’s Class: Critical episodes/remarks**

<table>
<thead>
<tr>
<th>Observation No.</th>
<th>Date</th>
<th>Lesson topic</th>
<th>Topic Type</th>
<th>Everyday examples used/cited</th>
<th>Episode/Remarks</th>
<th>Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>16.5.97</td>
<td>Inverse Variation</td>
<td>Algebra</td>
<td>Speed and time. Good consumption vs student population.</td>
<td>TS4 asked students to give examples of everyday situations involving inverse relations.</td>
<td>Use of everyday experience</td>
</tr>
<tr>
<td>04</td>
<td>16.5.97</td>
<td>Direct Variation</td>
<td>Algebra</td>
<td>Time taken for men to finish gardening.</td>
<td>Context used was OK but reality of the task questionable.</td>
<td>Role of reflection</td>
</tr>
<tr>
<td>08</td>
<td>27.5.97</td>
<td>Geometrical Constructions</td>
<td>Geometry</td>
<td>Use of construction in building</td>
<td>TS4 commented: “diagrams well labelled.”</td>
<td>Focus on content/lesson presentation</td>
</tr>
<tr>
<td>10</td>
<td>29.5.97</td>
<td>Geometrical Constructions</td>
<td>Geometry</td>
<td>None</td>
<td>TS4 commented: “Not much was done. Left to be completed by the students.”</td>
<td>Role of teacher/students</td>
</tr>
<tr>
<td>13</td>
<td>3.6.97</td>
<td>Cosine Rule</td>
<td>Arithmetic</td>
<td>None</td>
<td>TS2 noted: “A lot of time was spent on finding one value which is not the essence of the topic”.</td>
<td>Focus on content</td>
</tr>
<tr>
<td>14</td>
<td>4.6.97</td>
<td>Bearings and Distances. [Aim: to show applications of Bearings]</td>
<td>Arithmetic</td>
<td>Communicatio n between soldiers. Distances between Malawian towns.</td>
<td>TS4 spent most of the observation time taking notes about content rather than reflecting on the discourses.</td>
<td>Focus on content</td>
</tr>
<tr>
<td>15</td>
<td>4.6.97</td>
<td>Bearings and Distances. [Aim: to show applications of Bearings]</td>
<td>Arithmetic</td>
<td>Use of sunrise and sun set to locate directions</td>
<td>TS2 noted: “It’s easy to get cosines of obtuse angles on a calculator”. And added: “Are realistic examples necessary?”</td>
<td>Role of reflection</td>
</tr>
<tr>
<td>16</td>
<td>4.6.97</td>
<td>Bearings and Distances.</td>
<td>Arithmetic</td>
<td>Air travel, ocean submarines</td>
<td>An activity done in the school hall. TS4 just asked for volunteers without establishing the context of the activity in which the students were going to be involved (eg as soldiers). Spent most of time doing calculations on the floor.</td>
<td>Focus on content</td>
</tr>
<tr>
<td>22</td>
<td>12.6.97</td>
<td>Polynomials</td>
<td>Algebra</td>
<td>None</td>
<td>Quiet class apart from a little student talk just beside WM. TS4 solved the “impossible” problem as an example.</td>
<td>Role of students</td>
</tr>
<tr>
<td>26</td>
<td>26.6.97</td>
<td>Inequalities</td>
<td>Algebra</td>
<td>Cited thermometer readings to introduce negative numbers.</td>
<td>TS4 said “always draw a number line” as a hint for the exam, e.g to decide if the statement -2&lt;5 is true. TS4 said “please lend me your ears, don’t sleep”.</td>
<td>Role of assessment/Role of students</td>
</tr>
<tr>
<td>27</td>
<td>26.6.97</td>
<td>Revising Mid-Term Test</td>
<td>Algebra/Geometry/Arithmetic</td>
<td>None</td>
<td>There was a discussion about the value of zero, and some students felt that zero is valueless.</td>
<td>Role of assessment</td>
</tr>
<tr>
<td>34</td>
<td>2.7.97</td>
<td>Inequalities: Graphs of Inequalities in two unknowns</td>
<td>Algebra</td>
<td>None</td>
<td>TS4 remarked to students: “Do not be quiet, the exam timetable is out”. “Your friends in the other class have gone far. You are delaying yourselves by not answering”.</td>
<td>Role of assessment</td>
</tr>
<tr>
<td>Date</td>
<td>Event</td>
<td>Subject</td>
<td>Topic</td>
<td>Notes</td>
<td>Role of assessment</td>
<td></td>
</tr>
<tr>
<td>-------</td>
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<td>--------------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>-------------------------------------</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>2.7.97</td>
<td>Graphs of Inequalities</td>
<td>Algebra</td>
<td>TS4 urged students: “Answer please, the exam timetable is out. Your friends have already started Linear Programming”.</td>
<td>Focus on content</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>9.7.97</td>
<td>Linear Programming</td>
<td>Algebra</td>
<td>TS4 outlined steps to be followed when solving an LP problem. TS4 was asking and following up questions so that they lead to the idea she was looking for.</td>
<td>Role of assessment</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>11.7.96</td>
<td>Pythagoras Theorem</td>
<td>Geometry</td>
<td>TS4 gave them an assignment and said “I will check on Monday. You won’t enter the exam room if you don’t write it”.</td>
<td>Role of assessment</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>14.8.97</td>
<td>Arithmetic Progressions</td>
<td>Algebra</td>
<td>I noted: “TS4 could have let students finish the rest...” I noted that TS4 was rather tired (after a long exposition). TS4 said “After you finish question 1, bring it for marking”. They did not come to me, so I asked myself whether I really belonged the class.</td>
<td>Role of teacher</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>14.8.97</td>
<td>Arithmetic Progressions</td>
<td>Algebra</td>
<td>I noted: TS4 could have asked them to write something which is not an AP. I said: “someone is asking why 0 x (-7) = 0”. One student said “aah” meaning it was obvious. TS4 went ahead without following it up. I felt I had made an unwell comment.</td>
<td>Role of reflection</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>18.8.97</td>
<td>Arithmetic Progressions</td>
<td>Algebra</td>
<td>On finding the arithmetic mean, TS4 said “Good guess” but would have followed it up. There was excitement from students when she said “Let me give you my guess and see if it is a good guess”. Later on TS4 said “by the way when are you writing your exams?” after someone could not answer a question. On revision, she said “the lazy ones have said yes already” on whether to revise problems 1 and 2. TS4 then said: “You make me feel sorry”.</td>
<td>Role of assessment</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>25.8.97</td>
<td>Probability: (Introducing Probability Concepts)</td>
<td>Arithmetic</td>
<td>TS4 just read out questions from the list on the handout prepared as possible starting points for the lesson. TS4 did not use the content of “birth rates” planned.</td>
<td>Focus on content</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>26.8.97</td>
<td>Probability</td>
<td>Arithmetic</td>
<td>The language of “probability” became part of the discussion rather too quickly. Introduction needs to be connected to what students already know. One student asked: “what if we are tossing two coins, won’t it be possible?” – a sign that students were interested in probability concepts involving more than one event.</td>
<td>Focus on content</td>
<td></td>
</tr>
<tr>
<td>66</td>
<td>28.8.97</td>
<td>Revision</td>
<td>Algebra/Arithmetic/Geometry</td>
<td>TS4 was revising questions from a previous national examination paper. As a “reformed” teacher after the research, I thought she could have been less teacher-directed.</td>
<td>Role of assessment</td>
<td></td>
</tr>
</tbody>
</table>
## APPENDIX 17b

### Summary of Reflections on Classroom Observations in TS2’s Class: Critical episodes/remarks

<table>
<thead>
<tr>
<th>Observation No.</th>
<th>Date</th>
<th>Lesson topic</th>
<th>Topic Type</th>
<th>Everyday examples used/cited</th>
<th>Episode/Remarks</th>
<th>Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>16.5.97</td>
<td>Inverse Proportion</td>
<td>Algebra</td>
<td>Students travelling to town.</td>
<td>TS2 spent most of the time explaining. Can it take 2 hrs to walk 3 km?</td>
<td>Role of teacher</td>
</tr>
<tr>
<td>03</td>
<td>16.5.97</td>
<td>Direct &amp; Inverse Proportion</td>
<td>Algebra</td>
<td>None</td>
<td>TS2 asked loaders to report on their group work. Could have involved the rest in a discussion.</td>
<td>Role of students</td>
</tr>
<tr>
<td>05</td>
<td>19.5.97</td>
<td>Direct &amp; Inverse Proportion</td>
<td>Algebra</td>
<td>Walking or running speeds.</td>
<td>Students had problems estimating how fast they walk/run.</td>
<td>Role of students</td>
</tr>
<tr>
<td>09</td>
<td>28.5.97</td>
<td>Use of square root tables</td>
<td>Arithmetic</td>
<td>Uses of tables in real life eg in transport, bus fares.</td>
<td>Students used calculators as another resource for computing square roots.</td>
<td>Role of students</td>
</tr>
<tr>
<td>11</td>
<td>2.6.97</td>
<td>Area of parallelograms &amp; triangles</td>
<td>Geometry</td>
<td>None</td>
<td>TS4 commented: “Some of the group members were just making noise irrelevant to the lesson”.</td>
<td>Role of students</td>
</tr>
<tr>
<td>17</td>
<td>5.6.97</td>
<td>Areas of triangles on same base and same height</td>
<td>Geometry</td>
<td>None</td>
<td>I took students to the football pitch. To see parallel lines in practice. There was resistance among students to be physically involved in a “triangle” activity.</td>
<td>Role of students</td>
</tr>
<tr>
<td>20</td>
<td>11.6.97</td>
<td>Graphing Inequalities</td>
<td>Algebra</td>
<td>None</td>
<td>There was little opportunity to ask questions. Maybe it could be because TS2 was taking this as a new topic.</td>
<td>Role of students</td>
</tr>
<tr>
<td>21</td>
<td>11.6.97</td>
<td>Graphing Inequalities</td>
<td>Algebra</td>
<td>None</td>
<td>The only time when students were involved in the lesson was when one was called to draw a graph on the board.</td>
<td>Role of students</td>
</tr>
<tr>
<td>25</td>
<td>24.6.97</td>
<td>Graphing Inequalities</td>
<td>Algebra</td>
<td>None</td>
<td>TS2 just “finished up” everything after one student had drew a small line showing x is greater than 2.</td>
<td>Role of teacher</td>
</tr>
<tr>
<td>28</td>
<td>27.6.97</td>
<td>Inequalities</td>
<td>Algebra</td>
<td>None</td>
<td>I noted that students were just copying from each other. They could not say how they got their answers.</td>
<td>Role of teacher</td>
</tr>
<tr>
<td>31</td>
<td>1.7.97</td>
<td>Averages</td>
<td>Arithmetic</td>
<td>Ages of students, shoe sizes</td>
<td>A lot of explaining from TS2. Could ask “can you guess the mean?” before calculation.</td>
<td>Role of teacher</td>
</tr>
<tr>
<td>32</td>
<td>1.7.97</td>
<td>Averages</td>
<td>Arithmetic</td>
<td>None</td>
<td>Very few students were writing when the teacher was explaining</td>
<td>Role of teacher/Role of students</td>
</tr>
<tr>
<td>33</td>
<td>2.7.97</td>
<td>Averages: problem solving</td>
<td>Arithmetic</td>
<td>Results of a football match</td>
<td>TS2 noted that we needed to have included a fifth option “(c) All are correct” in order to clarify the meaning of “possible”.</td>
<td>Role of teacher</td>
</tr>
<tr>
<td>35</td>
<td>2.7.97</td>
<td>Averages</td>
<td>Arithmetic</td>
<td>None</td>
<td>One student said to TS2, “Can you give me chalk [so that I explain my answer]”. Students seemed to think that the term “average” means “shared equally”.</td>
<td>Role of teacher/Role of students</td>
</tr>
</tbody>
</table>

Note: Italic indicates TS2 was the observer. Non-italic indicates TS2 was being observed.
<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Topic</th>
<th>Subject</th>
<th>Other Notes</th>
<th>Student/Teacher Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>2.7.97</td>
<td>Averages</td>
<td>Arithmetic</td>
<td>None</td>
<td>Student control of lesson</td>
</tr>
<tr>
<td>39</td>
<td>9.7.97</td>
<td>Similar triangles</td>
<td>Geometry</td>
<td>None</td>
<td>There was a lot of excitement from students when they were giving examples of objects which are similar.</td>
</tr>
<tr>
<td>40</td>
<td>9.7.97</td>
<td>Similar triangles</td>
<td>Geometry</td>
<td>None</td>
<td>I noted: &quot;How do students feel when they are being lectured to&quot;. There were chorus answers.</td>
</tr>
<tr>
<td>42</td>
<td>11.7.97</td>
<td>Similar triangles</td>
<td>Geometry</td>
<td>None</td>
<td>Role of teacher/students</td>
</tr>
<tr>
<td>44</td>
<td>17.7.97</td>
<td>Test revision</td>
<td>Algebra/Arithmetic/Geometry</td>
<td>None</td>
<td>Role of students</td>
</tr>
<tr>
<td>46</td>
<td>11.8.97</td>
<td>Revision of test</td>
<td>Algebra/Arithmetic/Geometry</td>
<td>None</td>
<td>Knowledge taken as obvious</td>
</tr>
<tr>
<td>48</td>
<td>12.8.97</td>
<td>Formulae</td>
<td>Algebra</td>
<td>None</td>
<td>Role of reflection</td>
</tr>
<tr>
<td>49</td>
<td>13.8.97</td>
<td>Formulae</td>
<td>Algebra</td>
<td>None</td>
<td>TS2 noted: &quot;students were not comfortable with one example&quot;.</td>
</tr>
<tr>
<td>50</td>
<td>13.8.97</td>
<td>Formulae</td>
<td>Algebra</td>
<td>None</td>
<td>Role of students</td>
</tr>
<tr>
<td>53</td>
<td>14.8.97</td>
<td>Formulae</td>
<td>Algebra</td>
<td>None</td>
<td>Role of teacher</td>
</tr>
<tr>
<td>54</td>
<td>15.8.97</td>
<td>Quadratic equations: Application problems</td>
<td>Algebra</td>
<td>None</td>
<td>Focus on content</td>
</tr>
<tr>
<td>57</td>
<td>19.8.97</td>
<td>Linear equations</td>
<td>Algebra</td>
<td>None</td>
<td>Role of reflection</td>
</tr>
<tr>
<td>Date</td>
<td>Topic</td>
<td>Mathematics</td>
<td>Topic</td>
<td>Topic Notes</td>
<td>Reflection Comments</td>
</tr>
<tr>
<td>-------</td>
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<td>-------</td>
<td>-------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>59</td>
<td>20.8.97</td>
<td>Solving simultaneous linear equations</td>
<td>Algebra</td>
<td>Two different tanks, one being emptied and another being filled at the same rate.</td>
<td>I noted: &quot;I suppose the aim was to introduce solving simultaneous equations. I could see that the concept of scale got in the way of the aim&quot;. Could have used a simpler problem</td>
</tr>
<tr>
<td>60</td>
<td>21.8.97</td>
<td>Solving simultaneous linear equations</td>
<td>Algebra</td>
<td>None</td>
<td>TS2 wanted the class to use &quot;substitution&quot; method&quot; when one student was offering the use of &quot;elimination&quot; method. She said &quot;we will learn from him next time when we are going to do elimination&quot;.</td>
</tr>
<tr>
<td>62</td>
<td>22.8.97</td>
<td>Solving simultaneous equations using substitution method</td>
<td>Algebra</td>
<td>None</td>
<td>Student resisted the use of substitution because they found transposing equations difficult. Most of them got correct answer since they possibly copied from more capable ones.</td>
</tr>
<tr>
<td>64</td>
<td>25.8.97</td>
<td>Word problems on solving simultaneous equations</td>
<td>Algebra</td>
<td>None</td>
<td>Some of the problems which TS2 used (taken from the textbook) had outdated information e.g. about costs of newspapers.</td>
</tr>
<tr>
<td>67</td>
<td>29.8.97</td>
<td>Factorisation</td>
<td>Algebra</td>
<td>None</td>
<td>I noted: TS2 needs to have solicited other responses, reserve judgment till satisfied that you have established some general consensus.</td>
</tr>
<tr>
<td>70</td>
<td>3.9.97</td>
<td>Factorising quadratic expressions</td>
<td>Algebra</td>
<td>None</td>
<td>TS2 noted that she had seen one of the students use a method which she had never come across before, and that the book does not show other methods.</td>
</tr>
</tbody>
</table>
### APPENDIX 17c

**Summary of Reflections on Classroom Observations in TD2's Class: Critical episodes/remarks**

<table>
<thead>
<tr>
<th>Observation No.</th>
<th>Date</th>
<th>Lesson topic</th>
<th>Topic Type</th>
<th>Everyday examples used/cited</th>
<th>Episode/Remarks</th>
<th>Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>06</td>
<td>26.5.97</td>
<td>Standard form</td>
<td>Arithmetic</td>
<td>Newspaper report about national budget</td>
<td>Context not utilised. Newspaper was just passed on to students without connections being made.</td>
<td>Role of reflection (everyday experience)</td>
</tr>
<tr>
<td>07</td>
<td>27.5.97</td>
<td>Standard form</td>
<td>Arithmetic</td>
<td>None</td>
<td>Need to discuss procedure used for translating decimals to powers of 10.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>3.6.97</td>
<td>Polygons</td>
<td>Geometry</td>
<td>None</td>
<td>Used paper cutting to illustrate sum of exterior angles of a regular polygon. TD2 needed support when giving instructions to planned activity.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>9.6.97</td>
<td>Logarithms</td>
<td>Arithmetic</td>
<td>Barcodes.</td>
<td>TD2 commented that the lesson had gone well.</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>10.6.97</td>
<td>Simplifying algebraic</td>
<td>Algebra</td>
<td>None</td>
<td>A lot of disruptions. Students were very happy when TD2 went through the example again. One student said: &quot;are these coming on the exam?&quot; Only about 1% of students were taking notes.</td>
<td>Role of assessment Role of students</td>
</tr>
<tr>
<td>23</td>
<td>23.6.97</td>
<td>Pythagoras Theorem</td>
<td>Geometry</td>
<td>None</td>
<td>Some students were just sitting, some just copying from others, some said they had nothing to write on/with.</td>
<td>Independent/Active learning</td>
</tr>
<tr>
<td>24</td>
<td>24.6.97</td>
<td>Use of four figure tables</td>
<td>Arithmetic</td>
<td>None</td>
<td>TD2 said he was going to stop teaching in the morning because he gets tired.</td>
<td>Working relationship with teacher</td>
</tr>
<tr>
<td>29</td>
<td>30.6.97</td>
<td>Linear graphs</td>
<td>Algebra</td>
<td>None</td>
<td>Practical activity involving students moving steps on a grid on the ground according to some rule eg y = x + 1.</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>1.7.97</td>
<td>Linear graphs</td>
<td>Algebra</td>
<td>None</td>
<td>Some students were just sitting, saying they had neither squared paper nor ruler.</td>
<td>Independent/Active learning</td>
</tr>
<tr>
<td>43</td>
<td>16.7.97</td>
<td>Administering a test</td>
<td>Algebra/ Arithmetic/Geometry</td>
<td>None</td>
<td>Administering a test in TD2's class was frustrating. Students scrambled for question papers. They also wanted to stay in class so that they could &quot;peek&quot; at each other's answers. It started raining and we sought refuge in a primary school hall.</td>
<td>Independent learning</td>
</tr>
<tr>
<td>45</td>
<td>11.8.97</td>
<td>Areas of parallelograms and triangles</td>
<td>Geometry</td>
<td>Amount of surface one student occupies in the classroom, area of a garden.</td>
<td>TD2 noted: &quot;participation of the students was very low since they thought they knew the topic already. Try to be a bit fast in order to catch up time.&quot;</td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>12.8.97</td>
<td>Area of triangles on same base and between same height</td>
<td>Geometry</td>
<td>None</td>
<td>TD2 was rather judgemental and was quick to say: &quot;that one, it's correct&quot;.</td>
<td>Role of teacher</td>
</tr>
<tr>
<td>Date</td>
<td>Topic</td>
<td>Subject</td>
<td>Resources</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>-------</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>18.8.97</td>
<td>Revision lesson</td>
<td>Arithmetic</td>
<td>Work of the post office</td>
<td>We gave them some worksheets to be shared and used again next time. Some work sheets disappeared. Again some students just came without any writing materials.</td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>20.8.97</td>
<td>Profit and Loss</td>
<td>Arithmetic</td>
<td>None</td>
<td>Language used in the problem was contradictory to the content. It is the difference between list price and selling price.</td>
<td></td>
</tr>
</tbody>
</table>
| 61    | 22.8.97 | Ratio and proportion | Arithmetic | None | TD2 accepted all the following as meanings for the term “ratio”:
- “dividing into equal terms”,
- “a comparison of two things”,
- “sharing”. But he later said “I don’t think they [examiners] can ask: what is ratio”.
- Role of teacher/role of assessment |
| 68    | 1.9.97  | Similar triangles | Geometry | None | We had problems looking for a place to have our lesson. A further handicap was that students did not bring any protractors etc. Lesson did not go as well as I had expected. |
| 69    | 3.9.97  | Revision | Algebra/Arithmetic/Geometry | None | TD2 was giving students exercises from the 1995 national exam paper. |

<table>
<thead>
<tr>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher/role of assessment</td>
</tr>
</tbody>
</table>


# APPENDIX 18

## Key Students' Comments on the Average Lesson and their Associated Categories

<table>
<thead>
<tr>
<th>ID No.</th>
<th>Lesson comment</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2LEA016</td>
<td>I am not clear on how 7 / 13 averages free kicks are found? You mean to say if we take 20 divided by 2 does it give 7, 13? Then how? To that point I will stick on the answer (d) that is to say there are two teams so I will just multiply 10 x 2, total number 2 n team. 10 [and] 10. If not clarify the point there.</td>
<td>Did Not Understand</td>
</tr>
<tr>
<td>S2LEA031</td>
<td>It's because I don't understand well and because of not thinking deeply</td>
<td>Did Not Understand</td>
</tr>
<tr>
<td>S2LEA035</td>
<td>Today's lesson was very complicated. As a result we failed even to ask questions.</td>
<td>Did Not Understand</td>
</tr>
<tr>
<td>S2LEA052</td>
<td>For the time being [it] still shows that maths is a difficult subject.</td>
<td>Did Not Understand</td>
</tr>
<tr>
<td>S2LEA054</td>
<td>Maths was one of my best subjects in the [beginning] of my school career. I enjoyed it very much and I tried my best to get [it] right since standard 6. But now it became my enemy and now I see if [it] is possible, I give up. Everything ... goes because of method of teaching. ... Learning maths by this time I get nothing. I am just wasting my time for nothing, like a mangy dog fighting for a bare bone. But I can't do [otherwise]. I am going to [force] myself, maybe I can catch my teacher's method.</td>
<td>Did Not Understand</td>
</tr>
<tr>
<td>S2LEA015</td>
<td>[The] mathematical lesson was today was fine. But we students, after my own observations, I find that we oppose things which are correct. We lost time in such a habitat. For instance, today we have just been quarrelling, crushing on an easy problem “average”. Everybody knows what an average is, how to find it.</td>
<td>Disliked Dialogue</td>
</tr>
<tr>
<td>S2LEA013</td>
<td>I have to say that today is a non-forgettable day in maths. It has been a wonderful day since everybody was participating in raising up the points to solve the problems.</td>
<td>Enjoyed Learning</td>
</tr>
<tr>
<td>S2LEA018</td>
<td>I would like to encourage you that please Madam continue showing to us your best lesson and don’t lose heart to us because of our failings but trying to make anything good in order for us to understand much. If all the topics will be like today, I promise that I will show my encouragement and work hard.</td>
<td>Liked Dialogue</td>
</tr>
<tr>
<td>S2LEA028</td>
<td>I enjoyed learning it and I believe that I will also enjoy the coming lessons if I will continue understanding like the lesson on 2nd July.</td>
<td>Enjoyed Learning</td>
</tr>
<tr>
<td>S2LEA019</td>
<td>Try to make the lesson very interesting like the one which you have done today. I will never forget average even when writing examination. (S2LEA019)</td>
<td>Enjoyed Learning/ Felt Successful</td>
</tr>
<tr>
<td>S2LEA022</td>
<td>Today’s lesson was very interesting and I have enjoyed it... I made myself busy thinking, and I hope my thinking capacity also has improved.</td>
<td>Enjoyed Learning/ Promoted Thinking</td>
</tr>
<tr>
<td>S2LEA003</td>
<td>In fact now, I am convinced about how the Arithmetic is progressing. I mean the systems you have introduced are quite good to me and my friends. That now you are walking and solving the problems together... As you walk together each one of you tries their best to make us understand what another teacher hasn't made clear. For example, the problems of on 2nd July 1997 on averages I was quite clear to both methods which you have introduced[d].</td>
<td>Liked Collaboration</td>
</tr>
<tr>
<td>S2LEA048</td>
<td>To my side I think it's better to have two or three teachers in examineable classes than one teacher, because if you don't understand what the first teacher told you ask for the second teacher.</td>
<td>Liked Collaboration</td>
</tr>
<tr>
<td>S2LEA003</td>
<td>The 2nd July's maths lesson was just very good and I was happy about it. This is so because the way which you used about those 2 sums was just very good because everyone was able to say what he thinks about those 2 sums. In connection to that I can say that that way of teaching was very good because it can encourage us to think much in maths than just being told by the teacher. And also something which you just being told is easy to be forgotten while something which you did it on your own is very difficult for someone to forget it... Please continue that way of teaching up to the time when we will have our junior certificate exams.</td>
<td>Liked Dialogue</td>
</tr>
<tr>
<td>ID</td>
<td>Text</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>S2LEA007</td>
<td>Indeed it was very nice because each and every student were [able] to give out his or her suggestions. I would like to recommend this. And I know that this way of learning will [be] profitable to us. The sums which we were arguing [about], the truth came out at the end and we learnt more yesterday.</td>
<td></td>
</tr>
<tr>
<td>S2LEA010</td>
<td>Today’s maths topic was so nice to me comparing to other topics in the past. What made me to be so glad was the opposing and proposing of students. I think, how the class was, we took a long time discussing the same question. So it is very unfortunate to [fail] a question like that one because almost everyone was happy even though somebody sleeping he would wake up and find the sum and because of some disagreements between students they were able to get in the way the sum was going on.</td>
<td></td>
</tr>
<tr>
<td>S2LEA014</td>
<td>Today’s lesson was just fine because we were like debating so it was so interesting I wish it was like that everyday.</td>
<td></td>
</tr>
<tr>
<td>S2LEA016</td>
<td>Today’s lesson actually was good as we had time to oppose each other on answers of the sum. I have really enjoyed the lesson.</td>
<td></td>
</tr>
<tr>
<td>S2LEA056</td>
<td>I enjoyed the topic because there were two groups which were competing in the sums we had yesterday. This was due to how the question was saying about. We discussed it and after all we found that all the answer[s] were correct and I myself was in a group which said that all answers are correct.</td>
<td></td>
</tr>
<tr>
<td>S2LEA008</td>
<td>Today’s lesson was indeed a nice one. The reason is that the argument made many people to think more about the problem which written on the board.</td>
<td></td>
</tr>
<tr>
<td>S2LEA001</td>
<td>Today’s lesson was really nice to say the reality. This is because the examples which were given were the ones which happen obviously and also they were straightforward that a person can solve very quickly.</td>
<td></td>
</tr>
<tr>
<td>S2LEA024</td>
<td>Today’s maths needed much thinking for you to reason that all alternatives are correct... it was much understood and I felt it was a nice lesson.</td>
<td></td>
</tr>
<tr>
<td>S2LEA047</td>
<td>Today’s lesson I feel uncomfortable and felt my head pain because I was thinking very hard. But I got some of the points but others I got. In percent (%) I can say 75% I missed and 25% I got it.</td>
<td></td>
</tr>
<tr>
<td>S2LEA049</td>
<td>Today’s lesson was well understood simply it needed thinking deeply.</td>
<td></td>
</tr>
<tr>
<td>S2LEA020</td>
<td>According to the work we have done today. Truely it is well understood. And I thank you because of the teaching technique you have used, And today I have made my own decision that now I will be listening carefully to be one of the [our school’s] mathematician... To say the fact, this lesson I have understand it very well, and if I am going to fail it on examination then it will be my problem.</td>
<td></td>
</tr>
<tr>
<td>S2LEA051</td>
<td>If all the lessons which we have learned were as understandable as today’s lesson, everyone would have enjoyed them... I wish you could make all the lessons of maths to be quite simple so that small brains might grab some thing.</td>
<td></td>
</tr>
<tr>
<td>S2LEA008</td>
<td>It also made people to understand more about averages.</td>
<td></td>
</tr>
<tr>
<td>S2LEA012</td>
<td>My comment on today’s maths lesson is that it was more interesting and I have understood them all other than any topic in Arithmetic.</td>
<td></td>
</tr>
<tr>
<td>S2LEA037</td>
<td>I have understood all what the teacher was saying and I have no problems on averages and on top of that I have enjoyed today’s lesson than other lessons since we started learning averages.</td>
<td></td>
</tr>
<tr>
<td>S2LEA018</td>
<td>I want to inform you that I well understood about the averages and am sure that I will never fail when I meet a question about averages.</td>
<td></td>
</tr>
<tr>
<td>S2LEA052</td>
<td>I have seen that if well understood, its easy to be a mathematician.</td>
<td></td>
</tr>
<tr>
<td>S2LEA001</td>
<td>I felt it nice also because I can differentiate between a mean and a median. And also I have realised that not only equal numbers are used to find the average or the sum of the 2 teams’ free kicks.</td>
<td></td>
</tr>
<tr>
<td>S2LEA026</td>
<td>Today I have understand that not all numbers which are equal can give the average but as far as numbers no matter what values they are, [it’s] still possible to find their average (mean).</td>
<td></td>
</tr>
<tr>
<td>S2LEA049</td>
<td>Today’s lesson was well understood simply it needed thinking deeply... If maths had been simple like this every pupil would have been doing well.</td>
<td></td>
</tr>
</tbody>
</table>
An example of the coding process of the journal entries

Research Diary

2:10-3:20PM 4N. (N=63)

Recall on direct and inverse variation and introduce joint variation. Seems to be a very active class. Is lot of questioning from students. I gave examples of direct and inverse variation in other subjects. I think students see the connection (follow up). Had a discussion and the teacher after the classroom - on the examples of partial variation.

TCK

I had thought that partial variations always of form \( A - c + \frac{kb}{x} \) but not \( A = \frac{kb}{x} \). Gave an example of a tree collecting at 1000m east. Q1 and Q2.

C, T, V -> c, C = covered stands, A = common stands.

Need to revisit discussion since the teacher seems not to be fully convinced. (the other teacher was also present.).

TS4 realized that partial variations in trees also be \( A = \frac{kb}{x} \ + c \). More than 1 variable involved.

20/9/97 Language Observation at 4N

Main aim: introduce the concept of polygons, and give examples related to polygons.

TCK

Teacher keen to ask questions just like his students. Why? Perhaps he maybe stuck at the moment. I was exploring the questions in order to make the students also understand the questions so that they can answer. Teachers' knowledge limiting. eg negatives.

AL

I gave the students an activity to illustrate the ideas of re-entrant polygons. Look and asking the whole class seemed to indicate that most students enjoyed the activity. All groups came up with very interesting shapes of re-entrant polygons, and were keen to have the teacher see what they have formed.

ETHICS

Met a parent to one of the students (Z4). He wanted to know how much the student was to pay (for participating in the research).

"Seems students are so used to coaching and paying privately that this student thought there is nothing for nothing.

21/9/97

Interviewed 3 students at N2.

CTS

Changes students seem to see not clearly spelt out. But seem to indicate that teaching is slower now to enable students to understand. Why slower? Students seem to attach it to assessment. Thinks teacher wants them to improve from last term's math exam results.

Real activity concretizes students' experiences in mathematics learning. (eg measuring activity - distance and time).

UEE

Students seem to confuse between real examples from general classroom examples (solved problems). Next time I should emphasize real/everyday examples.

Debated with the BEd T at H1o 3 years teaching experience. Majored in maths during university training. Did geography, has done some research in geography needs follow up.
Research Diary

WRT

Felt OK to work with me.

ETHICS

Asked if students wanted to know if they are going to be paid for participating in the research. "Are we going to be paid?"

22/5/97 Classroom observation at 2A DEC

LP

Need to plan what to do during the lesson together with the teacher. I had started a review of topic when waiting for the teacher to come. Experienced difficulties leaving the lesson to the teacher. Some tension ensued. (Part of the problem is that the teacher seems to come to class largely unprepared - ill preparation, expecting that I would have prepared something.)

22/5/97

Planning meeting with the DEC teacher. Top: Standard form.

Discussed a rationale for using standard form. By newspaper editors using digits and words in reporting (eg $123,456). "That's enough. I'm through a magazine. Planned to read the extract to students, to see the application (why need to write in short form)."

23/5/97

Discussion meeting at HX.

Teachers reported that students even copy from each other during class (in teacher's presence). They asked on how this would be solved.

Planning meeting for Pythagoras theorem. Discussed an experiment to be conducted to find the relationship between the squares of sides of a right-angled triangle.

26/5/97

Lesson observation at 2A DEC.

TPK

The implementation of the lesson did not go quite according to plan.
1. Information (real-life) not communicated effectively. I just passed on the magazine to students without specifying what that was for.
2. The rationale for the topic was not implemented as discussed.

[Maybe the teacher thought the dissection was for his own knowledge rather than something that can be accessed by students also]

Content knowledge needs building.

As far as the research, I feel that next meeting I stress the things the teacher needs to tell/communicate to students, rather than leaving everything to the teacher's decision/discretion. Needs persuading.

However the use of familiar numbers captured a good proportion of students' participation in the lesson. Although class is too large, teacher also needs to be audible.

TVL
Research Diary

Should not underestimate kids. Expected them to cooperate with the level he had taken. Some students were thinking ahead. Teacher lacked sustaining enthusiasm. Instead said: I am considering things which are at your level. I feel I will function better. I will not affect you.

Should I focus on content?

27/5/97

WRT

Observing a lesson and co-teaching on standard form.

OCT

Difficult to work in a class of close to 200 kids.

28/5/97

Teaching at HLE Use of tables 810–850

Introduced a rationale for use of squares tables. Why tables?

AJ

Asked one student to find 5.23. Got 25.4! When asked to explain she/he got 27.04. Advantage of letting students explain.

TECH

Asked them: Do you see people outside class/school use tables? Silence for a few seconds. With persuasion, kids came up with: at tobacco market, bus conductors. I mentioned post office, telecom bureau.

Also asked: What about shops? Kids said calculators. For tables, they are asked to provide calculators.

A: have you seen a calculator before? All said no.

Are you allowed to use in school? Said it is forbidden. Teacher said it is not allowed.

Kids could be seen testing their results with a calculator (and using tables at the same time).

Some kids said it is easier to use a table. We need to be used to calculators first (eg 4.12).

LAN

I felt in good control of this lesson. I had students participating – although sometimes picking up a few individuals and persuading them helped to get them say something. Language helped too. Everyday language.

29/5/97

I had 3 successive classes at HLE in form 4 today. I planned to go through a construction problem the teacher had wanted to do for the lesson.

RREP

I wanted to get students to be more reflective in their work. For example, students are fairly familiar with constructing angles such as 60 degrees. I asked: What are you actually doing when you are constructing an angle of 60 degrees? (Process) I did not get a favourable response from all the three classes in general. I wanted to emphasise the point that students are actually using previous knowledge eg knowledge of equilateral triangles, kite, or other parallelograms. Why did I not get a good response?

TVL

I also wanted to get students helping each other, even working in groups, or working with their friends as they do the problem. Students seemed to like it! (I need to ask why). However, when students started working in groups and
APPENDIX 20

Final Interview with TS4 (8/9/97)

page 1

WM: Could I just have a little bit of your background, your educational background etc.

TS4: I did my primary at St. Peters Primary, formerly known as Kim Full Primary School. Then I transferred to Primitti Girls Primary School in standard 8, but I was not selected that year. Then I transferred to Catholic Institute (CI) in Blantyre. I was there for a term in Standard 8 and my uncle was transferred to Lilongwe so I went and attended at Nkhubungu Primary School in second term. Then I got selected to St. Mary’s Secondary school from there. That is where I did my secondary education from 1986 to 1990. Then in 1990 I was selected to Chancellor College where I did my Bachelor of Education (Science).

WM: Was that your first choice?

TS4: Ya.

WM: So you felt very happy.

TS4: Ya. So there I was awarded a degree.

WM: Why did you take that as your first choice?

TS4: There was this teacher, Sister Merlyn, who was teaching us physical science. I used to like the way she was teaching the subject. My ambition was to become a secondary school teacher.

WM: Just like her?

TS4: Yes, a science teacher in particular. That is why I chose Bachelor of Education (Science).

WM: So she was more or less your model of what you wanted to become.

TS4: Yes. Because she also gave me a fellow student who was with me in form 3. I was teaching her physical science. That was when I was in form 3 and I was teaching physical science. Unfortunately right now I am not teaching physical science.

WM: So when you went to chancellor college, did you have any choice on which subjects to follow? Or because it was all education science.

TS4: Ya, it was education science, and in first year there are five subjects: mathematics, physics, chemistry, biology and English. But I took geography instead of biology. Then in second year I dropped English, I went on with physics, mathematics, chemistry and education. Then in third year I left out chemistry, I proceeded with mathematics, physics, mathematical statistics and education. Then in fourth year I proceeded with statistics and mathematics, and education. Then in education we had psychology, philosophy and all these courses.

WM: I can see that you never left math.

TS4: No. I went on with maths.

WM: Could you tell me more about it? You seemed to have mathematics all through and through.

TS4: Anyway, starting from the primary, I liked mathematics. That is why I proceeded with mathematics.

WM: Did you find it easy, or why did you like it?

TS4: Anyway it was not as easy as it was supposed to be, but I was able to tackle some of the problems.

WM: What is the thing that really catches you with mathematics? Is it just that you like it naturally or there is something in it?

TS4: I can say I like mathematics naturally, but also the fact that when I have the problem and I try to solve it, I see that it follows logically. It follows logically and when I come to the final answer and I try to check, it is obvious, [and] true.

WM: So you just find that it follows naturally and there is logic in it.

TS4: There is logic in it and I am doing a thing which is true.

WM: What about the other subjects?

TS4: I couldn’t see where the answer is coming from. Of course they could have the correct answer but I didn’t know

Page 2

where it is coming from. For example, I could have the correct formula but I couldn’t know where it is coming from. That is why I said that I was not working from the truth. With maths I can see where I start and where I am finishing. There is some logic. I feel that this answer is coming from somewhere. Of course with science you can see from the experiments, but with chemistry I didn’t see where it is coming from.

WM: Molecular formulae, for example.

TS4: Yes, molecular formulae.

WM: So that is why you like maths because you can see that it follows naturally.

TS4: Yes.

WM: So it all comes from your background from primary.
TS4: Even my mum was encouraging me to do mathematics. When I had homework in primary school, she was trying hard to help me. That was the beginning of my liking mathematics.

WM: So it helped you to like it.

TS4: It motivated me to love mathematics. When I had an arithmetic problem for homework, my mum would say try it first. Then when I failed she would come up and help me. I was motivated to like mathematics with that.

WM: How do you look at how mathematics was handled during your training, at secondary school and college level?

TS4: At secondary school, we had different teachers, so there even if I had that spirit of liking mathematics, somehow I was disturbed with these different teachers.

WM: But you still maintained your liking of mathematics.

TS4: Yes, because I had books like Durell for Arithmetic, Geometry and Algebra. So I could follow them alone. And apart from that I had a brother who had finished secondary education at Likuni and he used to help me during holidays, for geometry and algebra. But I was solving alone in arithmetic. Only geometry and algebra were new things.

WM: What about when it came to college level?

TS4: Even though it was different mathematics, it was taught rightly. The material itself was well presented. Even when it came to exams I was able to tackle three-quarters of the problems. So I didn’t have much problems.

WM: How about the other educational courses? The curriculum and teaching studies section?

TS4: Especially philosophy of education, in that one I didn’t see the logic because [he] could touch here and there, and if you tried to connect the information, you could see that it is difficult to connect, especially philosophy. But with other parts it was ok. Because in psychology they are studying a pupil, their behaviours from stage to stage. And we could see those things happening, so we could see this is true. It logically follows. And sociology too.

WM: So they really made a connection.

TS4: Yes. They were making a connection with a pupil, that when you are teaching a pupil you should see this happening. We started with Piaget’s theory, studying a child from birth up to adolescence. So you see these changes happening. Then when you go out, we were seeing those things.

WM: That is an interesting point. So how many years have you been teaching in total?

TS4: If it part of occupation then I should say 3 years. But starting teaching as practice, I can say that I started in 1989, teaching my fellow student.

WM: So at this school this is your third year.

TS4: Yes.

WM: Could you just describe your classes?

TS4: We are supposed to have 40 students in class, but as of now we are having 60+ per class.

WM: How do you cope up with them?

TS4: Because of the high population that we have, we can say it’s ok. But for me as a teacher, it’s not comfortable.

WM: Does it affect your...

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TS4: Yes it affects the teaching itself because if you talk of pupil-teacher ratio, it is not that all good. Because when you are teaching, and giving an exercise in the classroom, and marking in the classroom to assess whether pupils have understood what you have taught, we are finding it difficult to assess the pupils within the classroom.

WM: So the main problem with those large classes is in terms of marking.

TS4: Yes.

WM: Is that the only thing...

TS4: Not only that but also if you have to teach and group them, supervision of the groups [will be a problem] because you will have a lot of groups. Each group will have maybe 10 students. So it is difficult for each and every member in that group to participate.

WM: So you have just come to accept.

TS4: Ya. We have just accommodated that. No objection because if you do like that it’s like we are hindering others to access the secondary schools. So we let them come and we see what to do.

WM: So maybe the point of large classes affects how you organise your classes. Could you just describe how you organise your teaching in the classroom. Or how you have been organising your classroom.

TS4: Anyway it is difficult to organise because the proper organisation is when you go in the classroom, you [check] for pre-requisite knowledge by asking some questions about what you have covered with them previously. Then when you introduce [a new topic], you write down the topic on the board. You start explaining what is, then give an example. Now if you want to see how this information is obtained, you have to divide them into groups.

WM: So you would divide them into groups.

TS4: Then give them a problem to discuss.

WM: So that is how you typically organised your [teaching].
TS4: Yes, yes. But that is not always. So in certain days you go there you explain, and you group them. You just write down the example on the board and you ask if it is well understood. Now if they say yes, you go on. If they say no, you repeat the example and explain it.

WM: So if the class says yes.

TS4: Yes, it's well understood, you go on. You give them an exercise. But if the majority says no, you repeat the example or you find a different example which will be well understood. Then you write down that, and you try to explain that.

WM: So you have talked about group work, exercises and more examples. So when you have the group work for example, would you also use any other materials? They have textbooks.

TS4: They have textbooks but not all of them

WM: How would you comment on the role of the textbooks that they have in the classroom?

TS4: Of course the textbooks in the classroom, they are not using them because they are not enough. And again when you are teaching they don't have that chance of using them. They use the textbook for reference.

WM: So those textbooks are mainly for reference.

TS4: To refer to them. I would say go and refer to such and such a page. You just pick a problem, not the already solved example. You just pick a problem from the questions. Then you do it as an example. Then after that you tell them this topic is from such and such a book on such and such a page.

WM: And then they can check.

TS4: They can check and then we encourage them to say: please practice. Relate those problems to those examples. But don't use it [the textbook] in the classroom. Because the problem there is that when you say open page so and so, and then you try to write down an example on the board, most of them will not listen. They will just be interested in reading the book. So that is why I am not often using the textbook.

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WM: And sometimes I could see that you could encourage them to go and look up something in the library.

TS4: Ya. Because in the library they have got different textbooks for mathematics. So maybe one book may explain that chapter in easy language.

WM: So in terms of the resources that the students use, it's just the textbooks.

TS4: Ya.

WM: And they have mathematical tables. Do they have enough?

TS4: No.

WM: I think the other time we discussed about calculators. You had an argument on calculators.

TS4: I said when we use calculators let's say starting from standard 1.

WM: Let's say at the secondary level. Because it could be one resource.

TS4: I said they will be lazy. Because if they are given simple numbers to add, instead of using thinking, they will just go to the calculator. Press the numbers, do the addition and come up with the final answer, instead of using their real brain.

WM: So the calculator would take the place of their brain.

TS4: Yes... It will take the brain into the calculator and do the operations. But simple calculations can be done in the head.

WM: How about complicated calculations?

TS4: [for] complicated calculations they can use calculators.

WM: But would you recommend it?

TS4: No at secondary school I would not recommend the use of calculators.

WM: Just for the same reason that it would take the place of the brain?

TS4: Ya.

WM: Because the kids see calculators in the society, in their everyday life.

TS4: Ya.

WM: I don't know how these people who are changing the curriculum will take up this issue.

TS4: Of course our society is changing. But I can say the financial problem that we have. Are those people going to provide calculators each and every year? Because we should expect losses there. Most of the calculators will be lost. Are we going to have enough money to buy calculators each and every year? Or else the pupils, are they going to manage to buy calculators?

WM: Because some of them tend to be quite expensive, for example the scientific ones. What about these simple ones?

TS4: Of course they can have simple ones, but most of the problems they have now are scientific... The small ones have square roots, but when we come to sines and cosines, logarithms, we need scientific calculators because we are in the modern world of science.

WM: I think these people who are changing the curriculum should discuss this.

TS4: They should discuss this. Of course we can introduce calculators into secondary school, but if we have these financial constraints, are we going to manage buying calculators each and every year?
WM: So what would be the main reason for you not accepting students to use calculators?
TS4: The main reason is the pupils will be lazy. And the other one is the supply of calculators, will it be constant?
WM: But the main one is them not being so active.
TS4: Ya.
WM: What about in terms of planning, what kind of planning do you normally do?
TS4: Ok, when I have the topic, then I study it.

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WM: Where do you start?
TS4: I start from the introduction.
WM: When you are starting to plan, you start from the introduction?
TS4: I start from the introduction. Then on introduction, you introduce the topic. Then under that you have to introduce the meaning of that topic. And what it is about that topic.
WM: So when today you are planning a lesson for tomorrow, what things do you look into?
TS4: If that is the case, you look for the time that you have. Let's say you have 40 minutes. Ok.
WM: So you look at the time.
TS4: The time you have, the number of pupils, then you go to the topic itself. Then you come to the outline of the topic. Under outline you have the introduction.
WM: That is normally how you would plan your lesson.
TS4: Yes.
WM: How much time will I have?
TS4: How much time am I having and how much time will this topic require since we have 40 minutes? Now am I going to cover the whole topic in 40 minutes? After you have decided you go to the title of the topic.
WM: So that really determines how much you give out for that lesson.
TS4: First of all you have to consider (time).
WM: So to you time is the most important [thing].
TS4: Ya.
WM: When you are planning.
TS4: When I am planning, time is the most important thing. Because whatever you have planned should be in line with the time. You shouldn't over-plan, you shouldn't under-plan.
WM: Are there any other things that you consider apart from time?
TS4: Apart from time, when you have that topic you consider the pre-requisite knowledge that the students have.
WM: So knowledge assumed.
TS4: Then under knowledge assumed you will consider: is this topic going to connect to what is already existing to them?
WM: How about on resources?
TS4: And again we come to teaching materials. After considering the pre-requisite knowledge, now you go to teaching materials. What materials are you going to use for the pupils to get the correct or the right information?
WM: And those materials would normally be what?
TS4: Like textbooks.
WM: Which they will not normally use.
TS4: Ya. They will not normally use but for you the teacher.
WM: So in terms of when you are planning yourself, it's mostly the things you are going to do. How much time you are going to have.
TS4: Yes.
WM: And of course you mentioned something about the number of students. That is what you look at.
TS4: Yes.
WM: How does that affect how you plan?
TS4: It will affect [in the sense that] if I go into the classroom, will I manage to supervise each and every student on this topic? To assess whether it is well understood or not. And how much time are you going to have with each student? Let's say you have 60 students and you give each one 2 minutes. How am I going to supervise each and every student? Now that is when you come up with groups.
WM: I could see that sometimes you didn't have much time to finish everything.
TS4: Ya.
WM: And sometimes you could...
TS4: Speed up.

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WM: Just to make sure that the main idea that you have planned is given out.
TS4: Yes.

WM: How about other materials say the examination, does it affect how you plan? I mean yourself when you are teaching.
TS4: When I am teaching an exam class, when planning I always make sure that when I am teaching this topic, I have to include a problem which will be examinable.
WM: So you made sure that...
TS4: I made sure that I have to do a problem which is examinable.
WM: What do you mean by that?
TS4: [By] that I mean the problem will maybe be examined by MANEB.
WM: So how do you normally find those examinable problems?
TS4: We have access to MANEBpast papers. Then we go through the questions. Then you come across a question under that topic. Then you know that this topic is examinable in this way. So when I go to the classroom, I make sure that I need to give examinable examples when I give an exercise. So I make sure I include one problem or two which are examinable.
WM: So you would normally take them from the exam papers.
TS4: No I just check the areas where they emphasise on that topic. Then select a question from the book, and change some numbers because most of the textbooks have got answers. So when you give them a problem from the book they just copy down the answer from the back of the book. I just change the figures.
WM: But you would say the examination was the main thing that affected you in your planning.
TS4: No.
WM: But it was just one of the things.
TS4: Yes.
WM: So what would be the main thing... You said time.
TS4: Time. You have to look at time.
WM: Covering the syllabus.
TS4: Ya. And again the other teaching materials apart from textbooks, like when you come to construction of perpendicular lines using set squares, here we don't have set squares and I left that topic. So [lack of] materials like set squares also affect planning.
WM: What other factors would you consider when you are giving them some homework or exercises or some activities to do?
TS4: Apart from examinable areas, I also consider the topic itself, whether the topic is examinable or not but that question should refer to them if they have understood the topic.
WM: You said if the question is not examinable...
TS4: Apart from choosing examinable questions, you can choose another question which is not examinable but maybe it is everyday applicable, outside when they leave school. You just choose that and give them to see if they have understood the topic.

WM: So applicable problems. So that would also affect how you choose the activities that you give them.
TS4: Yes.
WM: To make them see that they are applicable.
TS4: Yes. Not only for exams, but also when they go out in their everyday life, we need those problems.
WM: But they would not form the main exercises that you would give them.
TS4: That practical problem would be among.
WM: But most of them would not be applicable.
TS4: It would be one which would be applicable to several areas.
WM: But the rest would have to be those which are examinable.
TS4: Ya.

WM: And how would you make sure that all of the students are participating?
TS4: When I am teaching I make sure that they are participating when I ask a question then I see hands, and see that this one would like to [answer]. But those who would not raise up their hands, I would just mention them, then I find that they fail to give the information. So I saw participation when the pupils were raising their hands.
WM: So how did you make sure that the others are participating?
TS4: I mentioned their names. Or else when I went to the class I would say that when I ask a question, I don't want to see anyone raising up their hands. I would just start from there [in the first row] asking [them] to answer. So they should stand up and answer.
WM: I remember in one of the meetings you said it's not normally allowed.
TS4: Yes. It's not normally allowed but when you warn them that I will start from here, that is allowed. But when you ask a question and you mention a name of anyone who is not raising up a hand, that is not allowed. Because it's like you are taking him by surprise.

WM: And you wouldn't normally do that.
TS4: Yes, yes.
WM: You said that was from your teaching practice?
TS4: Yes.
WM: So they would emphasise that you shouldn't...
TS4: When you ask a question, you should pause. They have to think. Because when you choose a person at random who is not raising up a hand, it's like you are choosing him before you have given him time to think.
WM: Even if you have given them a chance to think?
TS4: If you have given him a chance and you see him playing, that is allowed. Maybe he is not paying attention. So you should mention him so that he should know that I am seen not to be paying attention.

WM: Do you have some principles which guide you in your approach to teaching?
TS4: Of course when we are talking of dressing, a teacher is supposed to dress smartly when going to the classroom.
WM: Ya, I could see that.
TS4: But when you go to the classroom and you want to teach a topic, what I do is when I go into the classroom, they will greet me always, and then I would greet them. Then I tell them to sit down. Then I look around the classroom and see the attitude of the pupils. If the attitude is not all that happy [good]...
WM: The attitude to you?
TS4: Yes.
WM: How they have received you that day.

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TS4: Yes... If their faces are not happy then I will try to create a joke which will make them happy.
WM: So when you want to teach them, you want to teach them when they have accepted you.
TS4: They have accepted me, and they have interest. They are ready to learn whatever material I have brought for them.
WM: So from what you are saying, it's like the students will not accept you if they are not interested.
TS4: Yes... Of course if they are not interested, I will still teach them.

WM: So when you look at your 3 classes, what normally happens?
TS4: In form 4 north, they were ever happy, but when I went to 4 west and east, they were not always happy. So when I went to these classrooms, I would see the attitude. If it is not [good] then I [would] create a joke and then they will laugh. After that then I will say let's go to our business. That joke is like a motivation, to bring them back from whatever was hindering them.
WM: But you didn't have problems in 4 north.
TS4: No.
WM: Why this difference? Is it that in 4 north they just accepted you from the beginning?
TS4: West and east used to be criticised. When my fellow teachers went there, they criticised them. So with that I think that is why sometimes they seem to be out of the classroom in mind.
WM: Why were they being criticised?
TS4: When they were teaching them, they didn't raise up hands to answer questions. Some of them they take themselves as if they are well-to-do people, so that one also affects them.

WM: Do you find the knowledge that you gained from your curriculum and teaching studies related to your approach to teaching?
TS4: Yes. The main thing is that you have to know pre-requisite knowledge. Know the attitude of the pupils.
WM: Before you start.
TS4: Before you start. Do not shout at them. Because that shouting will make them not to receive whatever you are giving them.
WM: And you made sure that you never shouted at them.
WM: They have never complained?
TS4: They have. The complaint was that I was fast, too fast.
WM: And you wouldn't want them to be slow.
TS4: No, no.
WM: You are always against slower learners.

TS4: Yes. Because they have to be fast, because they are given limited time. When it comes to examinations, they are given limited time. So if you train them to be slow, then that one will affect them when it comes to examinations.

WM: You are really against slow learners, slow thinkers.

TS4: Yes, yes. Anyway that much I can't be against...

WM: But you wanted them to be fast.

TS4: Yes I wanted them to be fast, to try to be fast. Because for those slow thinkers, it's natural. So I cannot be against nature.

WM: But you really wanted them to be fast.

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TS4: Yes.

WM: And you would want to train them to do that.

TS4: Yes.

WM: That is interesting.

...

WM: We have worked together for a number of months now. How do you feel about your thinking about teaching?

TS4: My teaching has been improved. I can say [it] has been changed. Because formerly I was not giving them everyday examples. I was just taking an example from the book, then explain it to them, and then give them an exercise. But the time we started this project, I saw that my teaching [has] changed tremendously. I was able to use everyday examples. Not only examinable [problems], but also that technique of applying to everyday life. So in some of the areas [in which I was weak, I have improved.

WM: You mentioned previously that you would also look at not just examinable areas, but also [look at] some problems which are applicable.

TS4: Yes.

WM: That was previously. Now you find that now you have...

TS4: That was problems only, not examples. Problems only, when I was teaching them. But now, I give them problems which are used in everyday life or problems which are examinable. But when it came to examples, during the time when we were working together, I was able to give them more practical examples as well as examinable problems.

WM: So at first it was mostly problems, but now it is [examples]. Could you say a little bit more on what you mean by examples, because an example can be an example of a problem?

TS4: Yes, it can be. But what I mean there is that the problem [is that one] written on the board and we solve together with the pupils... That is what I mean by an example.

WM: So now you were giving them more examples?

TS4: Yes, yes. More examples, both practical and examinable. That is what I mean by an example. I myself being the head of the class, and talking and talking, explaining that problem. That is what I mean by example.

WM: How has it happened that you have changed that way? What is the main thing out of the project that made you to do that? Maybe that is what the project was after.

TS4: No, not because that is what the project was after. Because we were sharing ideas. Because before starting this, I was having my own ideas, not from you my fellow teachers. But from your ideas and from her ideas, I could connect them, then you try to improve in the areas of my weaknesses.

WM: So it is the sharing of ideas.

TS4: The sharing of ideas is what helped me to change.

WM: So the main change there is that now you were giving them more examples.

TS4: Yes.

WM: Explaining more.

TS4: Explaining the topic more. Because before starting this project I was criticised that I was just giving them one example and then several problems. That is why they said the questions were not related to the example given.

WM: You were criticised by the...

TS4: If you see most of the questionnaires, they will say that the questions asked are not related to the example. The problem was [that I was] giving them a single example and then several problems.

WM: They didn't like that.

TS4: No.

WM: Do you think now they have changed their criticism?

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TS4: Yes. I think they have changed because from each area, we were covering 2 or 3 examples. But as of now, I think they have changed.

WM: As a result of your method now, of giving them more examples?

TS4: Yes.
WM: So your thinking now is that you should give them more examples.
TS4: More examples, ya. Both practical and examinable.
WM: Do you have any emphasis there? Say when you want to work with your classes in the future.
TS4: Anyway I cannot make much emphasis there because the only limitation is time. So I cannot put forward much emphasis. It will depend on the time that I will have... But I can say that if it is an exam class, the emphasis is on exam problems, examinable examples.
WM: That is according to your approach.
TS4: Yes, yes.
WM: So in terms of what you have personally gained from working in the project, is it just giving them more examples? Because that one has [also] come from the comments of the students.
TS4: Well I will be giving them more examples and also problems to practice. Both more examples and also questions to practice on their own.
WM: So if you were to describe the most important aspect of what you have personally gained from the project, it would be what?
TS4: It would be use of everyday examples. Use of everyday examples to explain more problems.
WM: So with this approach of using everyday examples in the classroom, how did it fit your pattern of working in the classroom? How did it affect how you were handling the classroom?
TS4: The use of everyday examples?
WM: Yes.
TS4: The use of everyday examples helped me to give out the information and the pupils were receiving the information with more interest. Because they were connecting the information with whatever they see, and it is real. It is real working. So the use of everyday examples was maybe making my teaching as fast.
WM: So they would catch the ideas fast.
TS4: Yes.
WM: And you would really want them to catch the message quickly.
TS4: Yes. For example when we were dealing with linear programming, I took an example of a tailoring shop where they make suits. Unfortunately, I didn't take them to "2 diamond" where they make these suits. But I explained about that place. So they have in mind that there is this 2 diamond shop and they do manufacture ladies' and gents' suits.
WM: You wanted to take them there?
TS4: Yes I wanted to take them there but unfortunately time was a limiting factor. But next time when I teach linear programming, I will take them to the factory.
WM: How did you want to organise your trip there? In terms of what would happen when you are there.
TS4: There I would say they are making these men's suits and ladies' suits. Now here we are seeing that they are not making negative suits. Do you see negative suits? That is where I would put the emphasis. That means the number of suits will be greater than zero or equal to zero. That is what I wanted them to see there.
WM: And you would also possibly ask the person who works there maybe to tell you what kind of, should we say maths?
TS4: Ya, ya what kind of maths they are using there.

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WM: It could be an interesting trip. And you would ask the girls and boys to take notes. And then you ask questions when you come to class. That is interesting.
TS4: Ya. Next time I will do it.
WM: But the problem of time.

... 
WM: So in terms of things which prevented you from fully achieving your goals, it's time.
WM: How do you feel about [how] you were getting the examples. We were working as a group, did you find that enough or how else would you find these examples apart from getting information from your friends?
TS4: Apart from getting information from my friends, ... Some of them just came into my mind that I should explain it to them. Like the examples on linear programming, in terms of limitations or constraints. For example if we take this campus, the fence is the limit where you are not supposed to go beyond. So that is a limitation concept. So some of the examples came in my mind while in the classroom.
WM: So I can see that some of the things that happened to you is to create examples for yourself.
TS4: Yes.
WM: When you had time.
TS4: Ya. Especially when I had a double period, 80 minutes.
WM: So how do you look at how you want to work in the future, after this?
TS4: I would like to go on with this use of everyday examples. And again, had it been that we had enough textbooks, I would love each and every pupil to have a textbook.
WM: You mean a textbook with examples.
TS4: Yes, a textbook with everyday examples. So that when I explain the example, they could go back for reference. And then they would see that this example is following logically.
WM: So that is what you would want to happen in the future.
TS4: Yes. These books should have both practical examples and examinable examples. The textbooks that we have, they have got only examinable examples.
WM: So you don't see many everyday examples there.
TS4: No. And again the examples that we give them should be in relation to the present times. Because if they are taking examples from the 60's or 70's, we are now in the 90's, examples should relate to the changes that are there now.
WM: So how do you hope to work within these limitations?
TS4: I will be making my own everyday examples. When I have a topic, I will think of everyday examples that are related to that topic.
WM: What would be your main argument for using this method? If someone came and said I wonder why you should be using this method at all. What would be your main argument in support of this?
We see that we are in a modern Malawi now. These are changing and these are happening everyday. So they have to use it in their everyday life even if they will not use them in their examinations. But after school, they need to use this method. So that is how I can back it up.
WM: So that is your main argument.
TS4: Yes.
WM: That is what is happening now.
TS4: That is what is happening now. There is no way we can stop giving out what is happening now.
WM: Do you see any argument against this?
TS4: Yes I see because they will choose not to do that.

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WM: I mean yourself.
TS4: Myself?
WM: Yes, are you supporting it 100% or there are some limitations with that method?
TS4: Yes I am supporting it 100%.
WM: There are no limitations?
TS4: Of course there might be limitations but as of now, I don't think of them.
WM: I hope it is not that we are the people who were working in the project. You don't see anything that would be against it?
TS4: No. Let me think.
WM: Or something that would prevent you from fully using that method.
TS4: Ok, that is ok. Now, if there is a thing that will prevent me from fully using it will be the teaching materials, the teaching aids which I can show to them, visually.
WM: So without those teaching materials [it would be a problem] but as a method, you strongly recommend it?
TS4: Ya.
WM: So what advice would you give to other teachers?
TS4: The advice that I would give to my fellow teachers is to go on using everyday examples. Because the use of everyday examples gives pupils a real picture, a real picture of the information that they are getting.
WM: And what do you mean by a real picture there?
TS4: The real picture is that when they have the information, they take it as something which is happening and they are seeing it happening and it is true. That is what I mean by picture.
WM: Do you have any specific examples of how this method worked in practice? With students, did you see some of the students getting this real picture?
TS4: Yes.
WM: Can you give an example there?
TS4: An example is bearing. We had an example of bearing. That is an airplane is leaving Chilika for Lilongwe and from Lilongwe to Kenya International Airport. Now what is the bearing of Kenya from Chilika? And these people when we did this practical problem they had in mind that this is what is happening. We go from Chilika to Lilongwe and from Lilongwe we go to Kenya, and from Kenya, it should be back to Chilika. Then what will be the bearing?
WM: They could see the picture, but they couldn't see the airport.
TS4: They couldn't see the airport but they could see the picture. Of course some of the examples that we will be talking about will not be within close proximity. There are places where we can't reach.
WM: Because they haven't been there before.
TS4: So you have to give them an everyday example which will give them a true picture.
WM: So what would be the main thing there that would make them to really see the real picture? What would be the main thing?

TS4: The main thing is that they have the picture so that next time when they come to that thing they should say that oh this is what she was saying.

WM: What I am saying is: what is the main thing for that activity there that made them get that picture?

TS4: The main thing was involvement of themselves. We involved the pupils themselves to do that. They will have that picture that I did this on that particular day.

WM: And the others could see how this other one was moving. So while they couldn’t see the airport in reality...

TS4: They would take that individual as an aeroplane.

WM: And this other one as a soldier.

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TS4: Yes.

WM: So when you were using these everyday examples, what is the main thing that students have benefited? From your observations or what you have seen through the project.

TS4: When I started using everyday examples, I saw changes in the pupils. Those inactive ones were active. What I mean by inactive [is that] they were not participating. When it came to use of everyday examples, they were taking part, they were participating fully. So they were active. And even if we came to chatting and we were trying to explain, they were able to do that. When it came to writing, they were able to write part of the information. Before that, they were unable to write anything.

WM: Do you have any students in mind?

TS4: Yes, Kenneth. Before we used everyday examples he was very inactive. That one who said x to the power 0 can’t be 1.

WM: 0 is valueless.

TS4: Yes. That one, and there is also

WM: Kenneth is not from 4 north?

TS4: He is from east. Again Triphonia, Joyce...

WM: Is it possible that I could talk to them?

TS4: They are in the exams.

WM: Ok, some other time.

TS4: But Triphonia is a little bit shy. You will get little information... There is also this one, Winston.

WM: He also does well.

TS4: Ya he does well but participation in class was not that good.

WM: So you see that some have improved.

TS4: Of course they have improved. But there is also this one, Daborito. Of course he was active but he has improved tremendously, in north.

WM: So if you had to describe the most important changes for the students, [they] would be what? Participation?

TS4: Participation, yes. That means they are able to get the information even if academically they will fall but when they go out, they will use that knowledge from here.

WM: So the main change there is just participation, and not improving their marks.

TS4: No. Of course some of them are improving, but Triphonia and Joyce are not improving. But participation in class has improved.

WM: So the thing that this method changes, you wouldn’t really say [it’s] performance. Just participation.

TS4: Well, we look for performance. If we look for performance, so we can say it’s both. Because some of them are anyway disabled but...

WM: That is interesting.

TS4: They are not able. They are disabled in maths. So I can say it will be difficult for them to improve. When I say improve I mean to pass. They can get an 8 or 7. They will just reach 39 and get a 9.

WM: Otherwise they are disabled.

TS4: Ya.

WM: I noticed some of them are saying things have changed...

TS4: They are saying things have changed. That means they understood the information but for them to use that and pass the examination, it’s difficult.

WM: And you don’t think it can help.

TS4: Well, it will help when they go out. Because they will use [those] real life experiences. But when it comes to exams they say for me to get 40 and get an 8, it will be difficult and I will sweat for that. But if they will try hard, [there is] no question they will do it.

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WM: I have found it interesting to talk to you. From your background, how you have gone through training and how you have worked in this project. Perhaps there are some other things which you want to really stress here. In addition to what you have said.

TS4: In addition, we need encouragement. These people we call methods advisers, they should visit us. Not only coming here to criticise us, but to help us to be good in weak areas. And these curriculum planners, they should see to it that we have enough teaching and learning materials. And again we must have some form of motivation to pupils... Give them presents like mathematics textbooks, where they will have mathematics plays. They have to play like games. Games in mathematics. We need to have mathematical puzzles, try to solve them. That must will motivate them.

WM: When you have these games and puzzles, how are going to fit in your time, because you have [little time].

TS4: No. That will be given in extra time... The outstanding winners should maybe be given some textbooks.

WM: So the puzzles there are a motivation.

TS4: A motivation. And again puzzles will help them to think because you cannot solve a puzzle without thinking. No. You can’t memorise a puzzle unless you have done it before.

WM: I will make sure that I look for a collection of puzzles before I go.

TS4: And again, in most schools we don’t have mathematics departments. We have science departments. Even though mathematics is a science subject, but it must be excluded from the science department, and it has to have its own department.

WM: Are there any other things? Maybe [with respect to] our working together...

TS4: Our working together must also continue. Of course we shouldn’t wait for the methods adviser to come, but within the school, the teachers that take mathematics should try to share ideas. That much will help.

WM: I will look for puzzles and pass them on to you. You won’t be handling the form 4’s. You will be handling the form 1’s, then it seems you will have lots of time.

TS4: Yes.

WM: You can even be a team leader.

TS4: Yes.

WM: Maybe you can also be the patron for the maths club.

TS4: Yes. We don’t have a maths club. We have a science club. The headmistress just appoints a club patron.

WM: What criteria does she use?

TS4: I don’t know. But if it is a club on its own, then maybe we can have a patron chosen from somewhere.

WM: I will need to campaign that at least the two of you should be [given some position]...

Do you find getting a bachelor of education, I mean those teachers who don’t have a bachelor of education, who haven’t done any teaching practice, those teachers who come say form Bundu college [of Agriculture] and just go and teach, do you find any difference? I mean do you find any disadvantage on their part?

TS4: Yes, there is a disadvantage on their part because they don’t know methodology, the approach itself. Because we see some of the teachers go there, they start teaching and maybe if the pupils fall to answer a question, they never go back to ask why he or she is failing.

WM: The teacher you observed.

TS4: Ya. They will just shout [and] shout.

WM: Like the teacher you observed.

TS4: Ya.

WM: You can see that there are some differences.

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TS4: Yes.

WM: Then perhaps having gone through the bed program and having gone through this project then if you had something like a team of you working with other teachers who have not done a bed, you will be in a better position to share that [experience].

TS4: Ya.

WM: I should say that I have really enjoyed working with you. I don’t think it will ever happen in my life. But I found out that the question of time was really pushing us. And sometimes I would feel guilty. I think we weren’t really teaching together for a longer time. To plan things.

Thank you very much
### APPENDIX 21

**Appendix 21: Analysis of Final Interview Transcript for TS4**

<table>
<thead>
<tr>
<th>Extract from transcript &amp; page number</th>
<th>Issue/Sub-issue</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>page 1: WM: What is the thing that really catches you about mathematics? Is it just that you like it naturally or there is something in it? TS4: I can say like mathematics naturally, but also the fact that when I have the problem and I try to solve it, I see that it follows logically. It follows logically and when I come to the final answer and I try to check, it is obvious, (and) true. WM: So you just find that it follows naturally and there is logic in it. TS4: There is logic in it and I am doing a thing which is true. WM: What about the other subjects? page 1-2: TS4: I couldn’t see where the answer is coming from. Of course they could have the correct answer but I didn’t know where it is coming from. For example, I could have the correct formula but I couldn’t know where it is coming from. That is why I said that I was not working on the truth. With maths I can see where I start and where I am finishing. There is some logic. I feel that this answer is coming from somewhere. Of course with science you can see from the experiment, but with chemistry I didn’t see where it is coming from.</td>
<td>Orientations to mathematics as a disciple</td>
<td>TS4 likes maths naturally. For her, the ways of working with mathematics are “obvious” and “true” since in maths, she “works from the truth”. She feels that in maths, the “answer is coming from somewhere”, from “logic”. TS4 views mathematics as having a beginning and an end, particularly when she compares mathematics with “experimental” subjects such as chemistry.</td>
</tr>
<tr>
<td>page 2: WM: How do you look at how mathematics was handled during your training, at secondary school and college level? TS4: At secondary school, we had different teachers, so there even if I had that spirit of liking mathematics, somehow I was disturbed with these different teachers. WM: But you still maintained your liking of mathematics. TS4: Yes, because I had books like Dereil for Arithmetic, Geometry and Algebra. So I could follow them along. And apart from that I had a brother who had finished secondary education and he used to help me during holidays, for Geometry and Algebra. But I was solving alone in Arithmetic. Only geometry and algebra were new things. WM: What about when it came to college level? TS4: Even though it was different mathematics, it was taught rightly. The material itself was well presented. Even when it came to exams I was able to tackle three-quarters of the problems. So I didn’t have much problems. WM: How about the other educational courses? The curriculum and teaching studies? TS4: Especially philosophy of education, in that one I didn’t see the logic because [he] could touch here and there and if you tried to connect the information, you could see that it is difficult to connect. Especially philosophy. But with other parts it was OK. Because in psychology, they are studying a pupil, their behaviours from stage to stage. And we could see those things happening so we could see this is true. It follows logically. And sociology too. WM: So they really made a connection? TS4: Yes they were making a connection with a pupil, that when you are teaching a pupil, you should see this happening. We started with Piaget’s theory, studying a child from birth to adolescence. So you see those changes happening. Then when you go out, we were seeing those things.</td>
<td></td>
<td>TS4 did not seem to like the idea of having different teachers teach her mathematics at secondary school. But she still maintained her interest in mathematics, especially since she had mathematics books which she could follow on her own. TS4 feels that her college mathematics was “taught rightly”, though it was “different mathematics” from what she had at secondary school. TS4 finds psychology, eg Piaget’s theory, more applicable to her teaching situation than philosophy of education.</td>
</tr>
</tbody>
</table>
WS: Could you just describe how you organise your teaching in the classroom. Of how you have been organising your classroom.

TS4: The proper organisation is when you go in the classroom, you [check] for pre-requisite knowledge by asking some questions about what you have covered with them previously. Then when you introduce a new topic, you write down the topic on the board. You start explaining what it is, then give an example. Now if you want to see how this information is obtained, you have to divide them into groups.

WS: So you would divide them into groups.

TS4: Then give them a problem to discuss.

WS: So that is how you typically organised your [teaching].

TS4: Yes, yes. But that is not always. So in certain days you go there, you explain, and you group them. You just write down the example on the board and you ask if it is well understood. Now if they say yes, you go on. If they say no, you repeat the example and explain it.

WS: So if the class says yes.

TS4: Yes, it's well understood, you go on. You give them an exercise. But if the majority says no, you repeat the example or you find a different example which will be well understood. Then you write down that, and you try to explain that.

WS: How would you comment on the role of the textbooks that they have in the classroom?

TS4: Of course the textbooks in the classroom, they are not using them. Because they are not enough. And again when you are teaching they don't have that chance of using them. They use the textbook for reference. They will not normally use it but it is for you the teacher.

WS: So those textbooks are mainly for reference.

TS4: To refer to them. I would say go and refer to such and such a page. You just pick a problem, not the already solved example. You just pick a problem from the questions. Then you do it as an example. Then after that you tell them this topic is from such and such a book on such and such a page.

WS: And then they can check.

TS4: They can check and then we encourage them to say: please practice. Relate those problems to those examples. But don't use it [the textbook] in the classroom. Because the problem there is that when you say open page so and so, and then you try to write down an example on the board, most of them will not listen. They will just be interested in reading the book. So that is why I am not often using the textbook.

WS: You look for the time that you have. Let's say you have 40 minutes. OK. How much time am I having and how much time will this topic require since we have 40 minutes? Now am I going to cover the whole topic in 40 minutes? After you have decided you go to the title of the topic. When I am planning, time is the most important thing. Because whatever you have planned should be in line with the time. You shouldn't overplan, you shouldn't underplan.

TS4 sees the maths textbook as important mainly for reference, not as a resource that students should be using while in the classroom because "they will not be listening". Students should only use it for practising problems. If they use it in the classroom, they would be paying more attention to the textbook than to her. [The textbook would "steal her show" Does she not consequently put herself at the centre of the discourse?]. She seems the textbook as being mainly important for the teacher, because not all students have maths textbooks. TS4 "picks problems from the textbook since they are already there". In her planning of the lessons, she considers the kind of "materials to use for the pupils to get the correct or the right information".

Time seems to be an important factor in TS4's decisions during teaching plans. [Fearing that she doesn't have enough time, and possibly leading to inflexibility, not taking risks to explore other ways of looking at the practice of teaching]
**TS4:** When I am teaching an exam class, when planning I always make sure that when I am teaching this topic, I have to include a problem which will be examinable.

**WM:** So you made sure that...

**TS4:** I made sure that I have to do a problem which is examinable.

**WM:** What do you mean by that?

**TS4:** [By] that I mean the problem will maybe be examined by MANEB [Malawi National Examinations Board].

**WM:** So how do you normally find those examinable problems?

**TS4:** We have access to MANEB past papers. Then we go through the questions. Then you come across a question under that topic. Then you know that this topic is examinable in this way. So when I go to the classroom, I make sure that I need to give examinable examples when I give an exercise. So I make sure I include one problem or two which are examinable.

**WM:** So you would normally take them from the exam papers.

**TS4:** No I just check the areas where they emphasise on that topic. Then select a question from the book, and change some numbers because most of the textbooks have got answers. So when you give them a problem from the book they just copy down the answer from the back of the book. I just change the figures.

**The examination factor**

When planning lessons, **TS4** makes sure that she includes problems which are "examinable". Since she has access to previous examination papers, she "checks the areas where they [examiners] emphasise on a topic". Then she selects similar problems from the textbook, making sure that she "changes the figures" since some of the problems would have answers at the back of the maths textbook students are using.

[Within this approach, learning would be characterised as reproduction, only learning about those aspects which are emphasised in the examination. Would this be the reason why some topics, eg probability, were given cursory attention by **TS4**, see fieldnotes.]

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**TS4:** When I am teaching I make sure that they are participating when I ask a question then I see hands, and see that this one would like to [answer]. But those who would not raise up their hands, I would just mention them, then I find that they fall to give the information. So I saw participation when the pupils were raising their hands.

**WM:** So how did you make sure that the others are participating?

**TS4:** I mentioned their names. Or else when I went to the class I would say that when I ask a question, I don't want to see anyone raising up their hands. I would just start from there [the first row] asking [them] to answer. So they should stand up and answer.

**WM:** I remember in one of the meetings you said it's not normally allowed.

**TS4:** Yes. It's not normally allowed but when you warn them that I will start from here, that is allowed. But when you ask a question and you mention a name of anyone who is not raising up a hand, that is not allowed. Because it's like you are taking him by surprise.

**WM:** And you wouldn't normally do that.

**TS4:** Yes, yes.

**WM:** You said that was from your teaching practice?

**TS4:** Yes.

**WM:** So they would emphasise that you shouldn't...

**TS4:** When you ask a question, you should pause. They have to think. Because when you choose a person at random who is not raising up a hand, it's like you are choosing him before you have given him time to think.

**WM:** Even if you have given them a chance to think?

**TS4:** If you have given him a chance and you see him playing, that is allowed. Maybe he is not paying attention. So you should mention him so that he should know that I am seen not to be paying attention.

**Students' roles in the classroom**

**TS4** felt that students were participating in the maths lessons when they were "raising hands". She seems to be submissive to her teacher education knowledge which recommended picking "only those who raise their hands". **TS4** claims that "when you choose a person at random who is not raising up a hand, it's like you are choosing him before you have given him time to think".

[However, not raising a hand does not mean not knowing anything about the topic being discussed. Their "silence" might just mean that some of them are still thinking about the problem. Their thoughts are yet to mature.]
Teaching principle:

Surveying students' "attitude" before beginning to teach. "Interest" them first

Apart from being "smart", TS4 considers it important to survey the classroom situation to make sure that "they are ready to learn", making sure that she feels that she is welcome in the classroom by monitoring students' attitude in the class. She makes sure that she gets them interested first before she can go on to "business". Getting students' interested in maths seems to be playing a rather casual role. If the kids are not interested, do not teach.

page 8
WM: Do you have some principles which guide you in your approach to teaching?
TS4: Of course when we are talking of dressing, a teacher is supposed to dress smartly when going to the classroom.
WM: Yah, I could see that.
TS4: But when you go to the classroom and you want to teach a topic, what I do is when I go into the classroom, they will greet me always, and then I would greet them. Then I tell them to sit down. Then I look around the classroom and see the attitude of the pupils. If the attitude is not all that happy [good]...
WM: The attitude to you?

page 8
WM: How they have received you that day.
TS4: Yes... If their faces are not happy then I will try to create a joke which will make them happy.
WM: So when you want to teach them, you want to teach them when they have accepted you.
TS4: They have accepted me, and they have interest. They are ready to learn whatever material I have brought for them.
WM: So when you look at your 3 classes, what normally happens?
TS4: In form 4 North, they were very happy, but when I went to 4 West and East, they were not always happy. So when I went to these classrooms, I would see the attitude. If it is not [good] then I would create a joke and then they will laugh. After that then I will say let's go to our business. That joke is like a motivation, to bring them back from whatever was hindering them.

TS4 says that the way she is teaching is a reflection of the knowledge she acquired from her teacher education. The knowledge she acquired tells her to make sure that pre-requisite knowledge is considered in addition to knowing the attitude or mood of students before starting to teach a lesson. She should not shout at students since "shouting will make them not to receive whatever you are giving them". However, she needs to be fast when teaching in spite of students' complaints about the same.
TS4: There is a disadvantage on their part because they don't know methodology, the approach itself. Because we see some of the teachers go there, they start teaching and maybe if the pupils fail to answer a question, they never go back to ask why he or she is failing... They will just shout [and] shout.

TS4 affirms the importance of undergoing training before beginning teaching. She believes that those teachers who have not had formal teacher education are at a disadvantage. [This affirmation was a result of her having observed another teacher who was not in the research team].

WM: How do you feel about your thinking about teaching now?
TS4: My teaching has been improved. I can say [it] has been changed. Because formerly I was not giving them everyday examples. I was just taking an example from the book, then explain it to them, and then give them an exercise. But the time we started this project, I saw that my teaching has changed tremendously. I was able to use everyday examples. Not only examinable problems but also that technique of applying to everyday life. So [in] some of the areas [in] which I was weak, I have improved... Previously, I was giving them problems only, not examples. Problems only, when I was teaching them, [but now] I give them problems which are used in everyday life or problems which are examinable. But when it came to examples, during the time when we were working together, I was able to give them more practical examples as well as examinable problems.

WM: So at first it was mostly problems, but now it is [examples]. Could you say a little bit more on what you mean by examples, because an example can be an example of a problem?
TS4: Yah, it can be. But what I mean there is that the problem [is that] one written on the board and we solve together with the pupils... That is what I mean by an example.
WM: So now you were giving them more examples?
TS4: Yes, yes. More examples, both practical and examinable. That is what I mean by an example. I myself being the head of the class, [and] talking [and] talking, explaining that problem. That is what I mean by example.

TS4 sees herself as having changed her approach in terms of the variety of problems she gave her students. She now includes "everyday examples" in addition to "examinable problems". In her teaching, she was also talking about some connections of the content with everyday life, not only concentrating on the problems written on the board.

Why give more examples?

The sharing of ideas as a group may have made TS4 think about giving everyday examples in addition to examinable problems. TS4 also seemed to have yielded to pressure from students since they were demanding more examples. TS4 was responding to students' needs.

WM: So your thinking now is that you should give them more examples.
TS4: More examples, yah. Both practical and examinable.
WM: Do you have any emphasis there? Say when you want to work with your classes in the future.
TS4: Anyway I cannot make much emphasis there because the only limitation is time. So I cannot put forward much emphasis. It will depend on the time that I will have... But I can say that if it is an exam class, the emphasis is on exam problems, examinable examples.

Change not sustainable because of time and examination constraints
WM: If you were to describe the most important aspect of what you have personally gained from the project, what would it be?

TS4: It would be use of everyday examples. Use of everyday examples to explain more problems... I will be giving them more examples and also problems to practice. Both more examples and also questions to practice on their own.

WM: So with this approach of using everyday examples in the classroom, how did it fit your pattern of working in the classroom? How did it affect how you were handling the classroom?

TS4: The use of everyday examples helped me to give out the information and the pupils were receiving the information with more interest. Because they were connecting the information with whatever they see, and it is real. It is real working. So the use of everyday examples was maybe making my teaching as fast.

WM: So they would catch the ideas fast.

TS4: Yes.

TS4 still finds that the approach of using everyday examples is worthwhile, and fits in her beliefs about what students should be able to do in class when she is teaching: to “catch ideas fast”.

WM: And you would really want them to catch the message quickly.

TS4: Yes. For example when we were dealing with linear programming, I took an example of a tailoring shop where they make suits. Unfortunately, I didn't take them to “2 diamond” where they make these suits. But I explained about that place. So they have in mind that there is this “2 diamond” shop and they do manufacture ladies’ and gents suits... There I would say they are making those men's suits and ladies' suits. Now here we are seeing that they are not making negative suits. Do you see negative suits? That is where I would put the emphasis. That means the number of suits will be greater than zero or equal to zero. That is what I wanted them to see there... I wanted to take them there but unfortunately time was a limiting factor. But next time when I teach linear programming, I will take them to the factory.

TS4: Apart from getting information from my friends, ... some of them just came into my mind that I should explain it to them. Like the examples on linear programming, in terms of limitations or constraints. For example if we take this campus, the fences is the limit where you are not supposed to go beyond. So that is a limitation concept. So some of the examples came in mind while in the classroom.

When taking students to a real-life situation where maths is used, TS4 seems to be keen to link the situation (eg suit-making) with the topic she is trying to teach. However, it is not clear about the extent to which broader connections involved (eg the type of maths the suit makers use in their activities) would be considered. The links which TS4 mentions seem to be more abstract (eg we can't have "negative suits"). However, the fact that TS4 is able to think about these links, sometimes on her own while in the classroom situation, is an important starting point for sustained change.
WM: So what advice would you give to other teachers:
TS4: The advice I would give to my fellow teachers is to go on using everyday examples. Because the use of everyday examples gives pupils a real picture, a real picture of the information that they are getting.
WM: What do you mean by a real picture there?
TS4: The real picture is that when they have the information, they take it as something which is happening and they are seeing it happening and it is true. That is what I mean by picture.
WM: Do you have any specific examples of how this method worked in practice? With students, did you see some of the students getting this real picture? Can you give an example?
TS4: Yes. An example is boring. We had an example of bearing. That is an aeroplane is leaving Chiloka for Lilongwe and from Lilongwe to Kenya International airport. Now what is the bearing of Kenya from Chiloka? And these people when we did this practical problem they had in mind that this is what is happening. We go from Chiloka to Lilongwe and from Lilongwe we go to Kenya, and from Kenya, it should be back to Chiloka. Then what will be the bearing?
WM: They could see the picture, but they couldn't see the airport.
TS4: They couldn't see the airport but they could see the picture. Of course some of the examples that we will be talking about will not be within close proximity. There are places where we can't reach. So you have to give them an everyday example which will give them a true picture.
WM: So what would be the main thing there that would make them to really see the real picture? What would be the main thing?
TS4: The main thing is that they have the picture so that next time when they come to that thing they should say that oh this is what she was saying.
WM: What I'm saying is: what is the main thing for that activity there that made them get that picture?
TS4: The main thing was involvement of themselves. We involved the pupils themselves to do that. They will have that picture that I did this on that particular day... They would take that individual as an aeroplane.

"Getting a real picture" Everyday examples give students a "real [life] picture of the information they are getting", although they would not be able to actually see the situations themselves. The example TS4 gives is from a modelling perspective rather than from a real situation. The use of an everyday examples serves the purpose of getting students physically involved in mathematics learning and enabling them to remember what the teacher was doing (e.g., how she was able to locate compass directions with the aid of a compass).
“students being able to write something”, gaining knowledge, participating more in the lesson??

WM: From your observations when you were using these everyday examples, is this the main thing that students have benefited?

TS4: When I started using everyday examples, I saw changes in the pupils. Those inactive ones were active. What I mean by inactive is that they were not participating. When it came to use of everyday examples, they were taking part, they were participating fully. So they were active. And even if we came to chatting and we were trying to explain, they were able to do that. When it came to writing, they were able to write part of the information. But before that, they were unable to write anything.

WM: Do you have any students in mind?

TS4: Yes, Ken. Before we used everyday examples he was very inactive. That one who said x to the power 0 can't be 1.

WM: So if you had to describe the most important changes for the students, I think it would be what? Participation?

TS4: Participation, yes. That means they are able to get the information even if academically they will fail, when they go out, they will use that knowledge from here.

WM: So the thing that this method changes, you wouldn't really say it's performance, just participation.

TS4: Well, we look for performance. If we look for performance, so we can say it's both. Because some of them are anyway disabled but... They are not able. They are disabled in maths. So I can say it will be difficult for them to improve. When I say improve I mean to pass. They can get an 8 or 7. They will just reach 39 and get a 9.

WM: Some of them are saying things have improved...

TS4: They are saying things have changed. That means they understood the information but for them to use that and pass the examination, it's difficult.

WM: And you don't think it can help.

TS4: Well, it will help when they go out. Because they will use those real life experiences. But when it comes to exams they say for me to get 40 and get an 8, it will be difficult.

“Constraints for change”

TS4: able to confirm that some students were able to write something. They gained some information even though they would fail in the end. However, TS4 cannot confirm substantial improvement in performance because she sees some students as “disabled in mathematics”. Though TS4 may seem to be examination-oriented, she sees that some students cannot make it. Hence more feasible goals for those students would be to gain more knowledge or just get a picture of what is happening.

As far as TS4 is concerned, there is need for more textbooks with everyday examples for the approach of “using everyday experiences to take effect”. More students should have textbooks, and the textbooks need to document everyday experiences that can be used in teaching the topics. Those textbooks should act as a reference, a standard, so that students should see examples as “following logically” with the requirements of the curriculum. In addition, the textbooks need to reflect the current life in the Malawian society.
WM: So what would prevent you from fully using that method?
TS4: Ok, that is ok. Now, if [there] is a thing that will prevent me from fully using it, it will be the teaching materials, the teaching aids which I can show to them, visually.
WM: So without those teaching materials [it would be a problem] but as a method, you strongly recommend it?
TS4: Yah.

TS4: Are those people going to provide calculators each and every year? Because we should expect losses there. Most of the calculators will be lost. Are we going to have enough money to buy calculators each and every year? Or else, are pupils going to manage to buy calculators?

TS4's attitude to the use of other learning resources such as calculators is rather inflexible. She stresses that calculators can encourage students to be lazy since the calculator will be thinking for them. ["It will take [their] brain into the calculator"]. Although admitting that the Malawian society is now changing (hence the maths curriculum needing to accommodate the use of calculators), TS4 is more concerned about the problem of whether it would be possible to supply calculators to all students, considering the large class sizes in most Malawian schools.
1. Which of the following is closest to how you feel about mathematics now?
(a) Very interesting  (b) Interesting  (c) Boring  (d) Very boring

Give reasons for your choice (Please circle one)
- Good teaching and clear
- Patience by the teachers
- Ability to help slow learners to catch up.

2. Do you think learning mathematics is important? Please give reasons for your answer.
(Kaphenurera masiye mukhophakathi? Tshuluntero izikawana)
- Yes!
- Because it encourages one's reasoning and solving day-to-day problems
- Strengthens one's ability to think deeply and apply knowledge.

3. How do you feel about how you have been learning mathematics this year? Explain.
(Kudzina bwapi mncwana ngenxambo matsamo chaka chino? Pali kwemba kweli kalise kugcine eyo? Fakakatsho)
- It was very fine because students had chance to argue during class time about other problems freely.

4. When you were learning mathematics this year, what things did you like most?
(Explanation: maths is what the children like most? Fakakatsho mncwana.)
- The way new topics were introduced eg Probability and Arithmetic Progression.
- The teacher could allow an individual to go in front and explain a problem to the class.

5. What things did you like least? Why?
(Pali zino zinemene isim lamba kubalulekile? Fakakatsho)
- Useless questions which dragged lessons.
- Slow learners who also dragged lessons.

Please feel free to add more information about what you have said above.
(Ngidi mahlali zonene zino? Malebo kahubalo kuibo? Lwazi lepela isi)

I would like to encourage the teachers to continue being patient towards students as was the case this year.

Thank you. (Zikomo kwamini, Thwengakho kwakha na.)
APPENDIX 23

Percentages of students for each response category for all questions in the final questionnaire

Students' views of mathematics (Q1A Final)

<table>
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<td>n</td>
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<td>Very Interesting</td>
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<td>Interesting</td>
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<td>48</td>
<td>72</td>
</tr>
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<td>Boring</td>
<td>2</td>
<td>2</td>
<td>5</td>
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<tr>
<td>Very Boring</td>
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<td>2</td>
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</tr>
<tr>
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<tr>
<td>Total</td>
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Reasons given for finding mathematics interesting (Q1B Final)

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<td>Partially Successful (PS)</td>
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<td>56</td>
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<td>18</td>
<td>23</td>
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<tr>
<td>Gain Knowledge (GK)</td>
<td>5</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Utility of Mathematics (UM)</td>
<td>17</td>
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<td>21</td>
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<td>Promotes Thinking (PT)</td>
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<td>Nature of Mathematics (NM)</td>
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<tr>
<td>Enjoy doing Maths (EM)</td>
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<td>6</td>
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<tr>
<td>Interested but Not successful (IN)</td>
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### Students' views of mathematics (Q1 First and Final)

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### Reasons given for finding mathematics interesting (Q1 First & Final)

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**Reasons given for the importance of learning mathematics (Q2 First & Final)**

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### APPENDIX 24

Number of Students and Percentage Passes for each Subject in 1996 and 1997

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APPENDIX 25

"What do we mean by learning": An extended discussion with TS2 and TS4 on the use of everyday experiences in the classroom

Notes of Meeting 18, TS2 & TS4, 15/8/97

WM: Do you have any comments on my summary of the discussion in our previous meeting?

TS4: On learning, I think we discussed that learning is the acquiring of ideas. But we haven't discussed that in detail.

WM: What do you think about my comment on page 3?

TS4: Here you said learning takes place when students' existing knowledge has been challenged.

TS2: In my case I would look at that as an extension of the meaning of learning. Or another definition of learning. Apart from acquiring new ideas, we could also look at it as where someone has some ideas then you are making that person think more about those ideas which he/she has. For example, the example on adjacent angles, for them adjacent angles mean angles on a straight line. Now the challenge there was to make them understand that when we are looking at adjacent angles, we look at any angles which are next to each other, not just on a straight line.

TS4: On that day we were saying what do we mean when we say "a student has learnt?" Did we have the meaning? What do we mean when we say learning has taken place? What are we looking for? Or how can we know that learning has taken place? On that day we were just discussing in general. What do we mean by learning? But what are the characteristics that we can see that learning has taken place in this student?

TS2: If we want to check, that is where asking questions and getting students' responses comes in. So you want some feedback. Now if we are looking at what is learning in such a case, are we looking at whether the ideas presented have been understood. If the student has learnt it means he has understood those ideas which were presented. Or at least some of the ideas. I don't know whether we look at learning as getting 100% of the ideas presented or ...

WM: The question again is: how shall we know that learning has taken place?

TS2: I thought you started with: what is learning?

TS4: We did that. But we didn't finish with that. How can we know that learning has taken place in this student?

TS2: I think last time we also discussed about why sometimes we give tests and exercises. And it was like we were looking at a check on whether the ideas have been understood. Also we went on to say that sometimes those tests are not a good method of checking if learning has taken place. Because sometimes the questions are restricted. You don't ask the whole range of what you have presented. Sometimes the question is restricted to some idea, not all.

TS4: So where is learning, do we expect changes in the person who is acquiring those new ideas? Do we expect changes? If so, what kind of changes? Positive or negative?

WM: She has introduced another key word here: changes.

TS2: Now it depends of what we mean by positive or negative.

Is learning an all-individual activity? TS4 is looking for "TOTAL," learning rather than "partial" learning. Sees learning as reproduction: failing to produce a similar object.

TS4: Let me give an example on positive change. Suppose you are there when a carpenter is making a table. You are there and looking at what is happening there. Then when you go away and you try to do it on your own, that means you have changed positively. But if you fail to do that but you know that this is what is happening, of course you have learnt but you haven't changed positively. You are failing to produce what you acquired from that person.
TS2: Maybe you are failing because you didn't get some idea? Some ideas are missing but you have learnt something?

TS4: when you have learnt that means you have learnt but you are failing to [do it on your own].

TS2: So is it negative?

WM: It could be that at least you have something in your mind, but you can't do something yet

TS4 seems to consider learning and transfer as obvious or unproblematic. If students know the formula and everything they need is on the board, TS4 assumes that students should have no problem in solving a given problem. If they don't it means that they have changed negatively.

TS4: For example today, remember we were teaching that example. And you asked a question to say: "can you check here?" And some of the pupils were failing to check. They learnt but they were failing to check. That means they have changed negatively. They had the formula for the nth term, but they are failing to check. But the whole information was on the board. But for them to check that information they were failing.

TS2: So do you call that negative? Because I was looking at like they couldn't think of how they were going to check. They had understood the problem, but it's like another problem which they can't solve. Because it was like two problems. The first problem was solving, then you asked them: 'can you check your answer, is it correct?'

TS4: Or even the same one, someone asked: suppose the fourth term is n, that means she had the information but is failing to use it. So maybe the changes maybe negative.

TS2: Or do we look at it as some misconception? Because sometimes one fails because somewhere he/she has misunderstood.

TS4: That misconception is also a negative change. You learnt but you are failing. So we can say that it's a negative change. I don't know [what] you understand by positive and negative change.

WM: I think this is [becoming] quite philosophical.

TS2: I am getting confused because somebody has learnt but somewhere he/she hasn't understood. But he/she has learnt. But now how do you decide to say it's on the other side? Since we are looking at negative and positive. We could represent them as maybe numbers on a number line.

TS4: Let's come back to changes, the question is when we say someone is learning, do we expect changes? or what do we expect?

TS2: Of course changes might be there, but they may not be 100% changes. We could say that one learnt something but somewhere maybe he/she doesn't get everything. Unless we define learning as 100% acquiring [ideas], getting all of them right or do we look at it as that he/she has got some right but somewhere he/she has missed something?

TS4: So there we have to define learning.

TS2: So at least some changes will be there, but it's not 100% because somebody hasn't understood everything. So there will be changes but it won't be the same in all the students. The change will not be the same because some have understood properly while some have understood all the ideas presented.

TS4: Looking at change (in learning) as being able to do something, rather than just knowing or developing some knowledge of it. Teachers want to see that the knowledge is being used in some way. What about those who try to solve the problem but do not get the "correct" answer?

WM: Where are those changes?

TS2: If there are changes then if I give them a problem, they would be able to solve. Maybe previously they wouldn't have been able to solve.
TS4: That is positive, but one who will be able to solve that problem and fails to get the correct answer, is that positive or negative? Of course you may solve it, but the answer is not correct. That is also a change but because he/she has failed to come to a correct answer, do we take that as positive change? He has tried that problem but failed to come to the correct answer. Has failed to finish the whole problem.

TS2: Now it will depend on the mistake he/she has made. Because maybe the mistake is not on what he has learnt. Getting the answer wrong might be from some other things which he/she didn’t get right. Is he getting the answer wrong because some of the concepts presented haven’t been understood?

[A CONCRETE EXAMPLE]

TS4: It happens that someone can go to a friend: my friend, for you to become rich, you have to go to the bank and steal. You go there you are caught. You are led astray.

WM: So did that person learn? I mean, before he or she went to the bank to steal?

TS4: I think he hasn’t learnt. Because he hasn’t seen that person going to the bank and stealing.

WM: You are saying he hasn’t learning because the person who was teaching him or her...

TS4: Didn’t do that actual thing.

WM: So that he could see?

TS2: On the same example, I am thinking that sometimes when somebody tells you something, you yourself have to think about it. Because here we are talking about someone telling you some facts. It also depends on being convinced that these are correct facts. For example in class we would ask them “why is a negative times a negative positive?” They learnt or somebody told them that negative times negative will give a positive answer, but they never thought about why should it give a positive answer? So you yourself must think about the information you get. For example that one going to the bank, if he doesn’t get caught, will you think he has learnt?

TS4: To him I think we will think he has learnt how to become rich.

TS2: So it depends on the outcome, whether he gets caught or not?

WM: So would you call that learning? Before he goes to the bank?

TS4: It might be learning. It might be learning!! Yah. Because there are some changes there.

A number of “levels” of learning seem to be emerging, i.e., learning as:
- accepting ideas as they are, then
- thinking about those ideas, and then
- testing how those ideas work in practice, and
- going back and reflecting on original ideas

[ANOTHER CONCRETE EXAMPLE] About “pie”

WM: Last time you did a lesson that involved using the value of “pie”, i.e. 22/7. Did the students ever come across “pie”, before coming to that lesson?

TS2: Yah they had. But perhaps it’s just those types of things where you just accept them as they are.

WM: Now when you ask them a question: “why pie?” What will they say? Or when you say “why is the area of a circle pic r squared”, what will they say?

TS4: They will say it’s a formula.

WM: When you ask them “why is it like that”, what will they say?
TS2: They told us that area of circle is pi r squared. That's what I learnt in primary school.

WM: Suppose now you say, let's do something to find out more. If they find now where the formula is coming from, what shall we say about their learning between now and when they were [at primary]?

TS2: It's broader now. They have expanded on their [learning]. In terms of how much they will "weigh" then they are better off.

[ANOTHER CONCRETE EXAMPLE]: X to the power of zero is 1? Adjacent angles on a straight line.

Knitting, casting on/off.

WM: Let's take the example when we had a discussion about the idea that "the number x raised to the power of zero is equal to 1". Someone said zero is valueless. I think it also a similar example to the one which you had in form 2.

TS2: About d to the power 0.

WM: Yes, you had the same thing. Maybe let's take a simpler example. All of them know about adjacent angles... So we assume that that person has got something. That something may or may not be helpful for that person to learn well in that lesson. So the ideas which the student has before he/she comes to the lesson may or may not be helpful for understanding that lesson. Suppose the idea they have is a misunderstanding. I would think that maybe if we corrected that misunderstanding, if we challenged that this thing which they think they know very well and it's true, if we showed them in some way that it is not like that, and if we convinced them, not by forcing them, that this is not like what you had before, then maybe that person will change his/her mind. For example on adjacent angles. They were saying that adjacent angles always add up to two right angles.

TS2: That adjacent angles are always on a straight line.

WM: Is that true always?

TS2/Ts4: No

WM: But what did you notice on that day?

TS2: Of course they were some who still did not get it, but at least the majority understood in the end that they misunderstood what they learnt. What they learnt was that "adjacent angles on a straight line add up to 180 degrees". Now to them they left out the bit where the teacher said "straight line" which was the key word for them. It was a key word. And they missed that out and just generalised that to any adjacent angles.

WM: Maybe I should just say that for us to say learning has taken place, we take first of all the ideas that you have before you have learnt. The way I think we can say learning has taken place is: if the ideas that you now have, if they "fit" the pattern, if they make sense,... Maybe we need an example here. You ladies are very good at knitting. If you were knitting and someone else says let me take over because you have something to do in the kitchen. And when you come back you find that [the new 'knitting' is not quite like what you have done already]. What will you say there? You will say what...

TS4: That the pattern is not correct.

WM: You will say it is not as accurate. Ideas should be connected to what they know or have done already. Like your knitting pattern. They should be connected in some way, because if they are not connected, if you don't connect the ideas, that is why you will find that some students will just memorise.
The team is seen here as engaged in a process of building up understanding through dialogue and negotiation. Other crucial concepts evolve such as the question of whether memorisation can be taken as learning. When you have understood what you have memorised, have you learnt? Is it memorisation any longer?

TS4: Can I stop you there. If we say that the ideas are not connected to what you have already, and you say that that is why some students memorise, can memorisation be taken as learning or not?

TS2: It depends on what type of memorisation. Sometimes you memorise so that it helps you when you want to give back that information... Sometimes you might have learnt but you want to simplify your work so just memorise. You have learnt something but you want to simplify your work because you don't want to think about it so hard. So you just memorise it. Let's take formulae. Sometimes one would just memorise that because he/she doesn't want to do derive. Because there are some formulae which are easy to derive because you don't have to always remember the formula. So sometimes where one memorises, sometimes there is learning. But maybe in other cases one may memorise without understanding what he/she has memorised... Understanding what you have memorised. Sometimes one understands what he/she has memorised. He/she has learnt.

This idea of memorisation went on up to a point where members felt that in general, the new ideas that are coming in must be connected to the previous ideas, for us to say learning has taken place. TS4 emphasised that if the new ideas are not connected to the previous ones, that is why we some students just memorise.

WM: If the ideas are not connected, let's take an example whereby you challenge a student's knowledge. For example when we recall the example of adjacent angles, how did you see the students there (in form 2E)?

TS2: Some were convinced about what they had in their mind.

WM: Why were they fighting? Why did some come to the board and said, "This is my best answer"? On the discussion about averages? Why did that student (who said angle a is equal to 40 degrees (recall the incident on alternate angles)) act like that?

Summarising the discussion and connecting it to the idea of using everyday experiences. "Casting off" "casting off".

Looking for the opportunity to dialogue, to discuss the ideas and thinking behind the approach of using everyday experiences. Such thinking and dialogue needed to take place before ideas could be taken on board.

TS2: In my case I just look at learning as getting new information or ideas but not necessarily 100%. That is why you find somebody getting 50% in a test. He got some but he didn't get all of them. He learnt something but not everything which you presented. So just getting some ideas from what is being presented, that means someone has learnt.

WM: So learning is not just taking in ideas but also doing something to the ideas. Trying to understand them as you have said.

TS4: It is an active process. And also we can add that where there is learning we can have changes or not.

WM: But what can we say about those changes?

TS2: Because if somebody has learnt something, there is something new in him which he didn't have at the beginning. So there is some change. But not necessarily the expected change where somebody has learnt everything.

WM: So there is some change somehow, but we can talk more about that change. Someone used the word "weigh". How much change is it? But I just want to say this. The keyword here is "connect": connecting the new idea and the previous idea. Why do we think we are using everyday examples in our teaching?

TS4: Because everyday examples are what they will see in everyday life. When they go out they see what is happening.
TS2: And then when they get those new ideas they will connect the ideas to [what we are teaching]. And maybe it will be easy for them to understand what you are explaining, it's like you are following the trend of their life, whatever they have seen in life.

WM: So do you see why we have some hope in what we are investigating, that they will be able to connect ideas?

TS4: Yes we have.

WM: Because if you know something already, and when someone wants to tell you something and connects to something you know already, it might make more sense. First of all, that something which you have is already yours. So we have connected it to what we are trying to teach. So we have connected the new idea with what student already knows. Perhaps that is why we are saying maybe it would help him/her to understand better. If we don't connect with what they already know from everyday experience, then the students will think that these ideas are just for the classroom, that they have no relationship with what happens outside the classroom. That is how we are trying to make students appreciate the value of mathematics. So that is why we are emphasising on the use of everyday examples. Because if learning involves students connecting one idea to another, and the more everyday examples we use, the more connections the students may be able to make. That is why in linear programming you tried to use as many examples as possible (eg. tailoring, school kitchen, etc). Just like when you are knitting a piece of cloth, you want the knits to be well connected in order to have a better pattern. Even those people who make baskets, they will try to connect the weaving materials in such a way that the pattern is strong. If they do not connect the materials properly, the basket will just be wobbling. It won't be so strong. How do you make your knits stronger?

TS4: We cast on at the beginning, then at the end when we are finished, we cast off. So when casting off you make sure you don't lose any stitch.

WM: So the key word there is connecting.