The implementation of lesson study in mathematics: The case of Zambia

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Doctor of Philosophy

Deakin University

October, 2018
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Abstract

Many countries have adopted Japanese Lesson Study to improve the quality of teaching and enhance students’ learning experiences in subjects such as mathematics. Lesson study was first implemented in Zambia in 2005 in Grades 8 to 12 science in the Central Province with the help of the Japanese International Co-operation Agency (JICA). Its adoption followed the introduction of free basic education (Year 1 to 9) in 2002, through the Basic Educational Sub-Sector Investment Programme.

The Ministry of Education considered lesson study as a vehicle for reforming the three primary areas of mathematics education it had identified: teacher-centred instruction, the mathematics curriculum, and continuing professional development of mathematics teachers. While lesson study remains a voluntary activity in many countries, in Zambia the Ministry requires every government primary and secondary school, as well as government-aided schools to implement lesson study in every subject area.

This study investigated the implementation of lesson study in secondary mathematics in Zambia, by focussing on: how lesson study was defined by the Zambian Ministry of Education and interpreted by in-service providers, school administrators, and teachers of mathematics; the mechanisms put in place to establish lesson study as a model for professional development in Zambian schools; how lesson study is being implemented at the school level; and the effects of implementing lesson study in Zambia.

The study uses an Onion Rings Model, comprising five rings – the Ministry of Education, In-service providers, School environment, Teachers, and Implementation of lesson study at school level – to frame our understanding of how lesson study implementation is shaped by the nested relationship of the elements of the five rings.

Case studies were carried out in three secondary schools in three districts in Zambia. At each school, two lesson study cycles were observed and video-recorded; interviews were carried out with the Head Teacher, the Continuing Professional Development (CPD) co-ordinator, and the two teachers who taught the research lessons. Relevant documents were collected, together with the results of Grade 12 national examinations in mathematics. Data were collected over a period
of six months. Interviews were also conducted with officers at the Ministry of Education Headquarters, District Education Board Secretaries, and Standards Education Officers. Transana and NVivo software were used to transcribe and code the video- and interview-data.

The six lesson study cycles observed revealed that teachers followed the eight steps of the Zambian lesson study model, but they did not explore in detail many aspects recommended in the policy. It was evident that the time spent planning research lessons was too short to explore in detail all the necessary aspects of the lesson. Similarly, very little time was spent reflecting on the effects of each research lesson. The study shows that the mathematics focus across the case schools was more on mathematical skills than elevating student mathematical thinking, and that teachers did not explore in detail the opportunities that could enhance their professional development, improve mathematics curriculum, or transform teacher-centred lessons to student-centred lessons.

Understandably, it appears that the beliefs and attitudes of Japanese teachers, that underpin the process of lesson study, have not readily transferred to teachers in Zambia, as the teachers who participated in this study lacked deep understanding of some of the critical features of lesson study, and together with the institutional challenges posed by the inadequate resources (funds, transport, time), the low priority some school administrators attached to lesson study, the competing school activities in which mathematics teachers were required to participate, all mitigated the effects of the implementation.

Investigating the effects of lesson study, showed that it had started helping teachers to appreciate teaching as a public activity, and that teacher collaboration, at three case schools, had improved within mathematic departments, and between teachers and school administrators.

Chi-square statistics were used to analyse student pass rates on the Grade 12 mathematics examination. The results were inconclusive, with improvement in student pass rates from 2011 to 2014 in some cases, and a decline for others, although the results of the analysis do not necessarily imply that lesson study accounted for the improved student pass rate, or the decline.

Important implications of this study for policymakers are to prioritise identifying and defining more explicitly the nature of Japanese Lesson Study, including the beliefs and attitudes of Japanese teachers that underpin the process.
In addition, there is an obligation to adequately fund and ensure the effective functioning of lesson study support mechanisms. Finally, there must be a commitment to ensuring that teachers develop deeper insights into the critical features of Japanese Lesson Study and thus include these in their professional practice.
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Chapter 1 Introduction

This chapter presents the background information to the study. It provides some information about Zambia, its education system, the student performance in mathematics, mathematics education reforms, introduction of lesson study in Zambia, and the focus of this study.

1.1 My journey to PhD research in lesson study

My interest in undertaking PhD research in lesson study in mathematics is rooted in the experiences I had as a student in secondary school, as a pre-service mathematics teacher, as a teacher of mathematics, and taken when undertaking Bachelor of Education in Mathematics and Science, as a trainer of diploma pre-service and in-service teachers of mathematics, and when undertaking Master of Philosophy in Higher Education in the University of Oslo in Norway. During my primary and secondary years, I believed that mathematics was a difficult subject. As I progressed to pre-service training college and later to in-service training at universities, my perception of mathematics changed through my active involvement in mathematical study and seminar groups in which we tackled problems meticulously and collaboratively.

Further, I have an interest in seeing how best educators can solve the puzzle of persistent poor student performance in mathematics in many countries, including Zambia, and perhaps correct the deep-seated belief that mathematics is a very difficult subject. If mathematics was not a compulsory subject in primary and secondary schools, as it is in many countries, many students may not enrol in it, and even those who do enrol may drop it later.

My classroom teaching experience has taught me one important lesson: that teacher-directed classroom instruction may be necessary but is insufficient to provide opportunities for students to enjoy mathematical activities. Therefore, when I first heard about Japanese Lesson Study during a workshop, facilitated by Zambia Ministry of Education officers whom the Zambia government had sent to Japan to learn about lesson study, I became interested in examining how non-Japanese countries such as Zambia were implementing lesson study in mathematics.
1.2 Some information about Zambia

This section gives background information on Zambia, the geography, the people, and the government.

1.2.1 Geography

Zambia is a landlocked, Sub-Saharan African country as shown in Figure 1.1

Figure 1.1. Map of Africa

It has a total area of 752,618 square kilometres (slightly larger than France), of which 9,220 km² are water.

Zambia shares its borders with eight other countries: Angola for 1,110 km, the Democratic Republic of the Congo for 1,930 km, Malawi for 837 km, Mozambique for 419 km,
Namibia for 233 km, Tanzania for 338 km, Zimbabwe for 797 km, and Botswana, for less than 1 km.

1.2.2 The people of Zambia

The population of Zambia has increased almost threefold from 5.7 million in 1980 to an estimated 15.5 million in 2015.

There are 73 ethnic groupings in Zambia with seven major languages used besides English, which is the official language.

1.2.3 Politics and Administration

Zambia gained its political independence from Britain on 24 October 1964. Initially, Zambia adopted multi-party politics, from 1964 to 1972, after which it became a one-party state. The 1973 constitution provided for a National Assembly. The Central Committee of the United National Independence Party (UNIP), the sole legal party in Zambia, formulated national policy. The cabinet executed the central committee’s policy.

In accordance with the intention to formalize UNIP supremacy in the new system, the constitution stipulated that the sole candidate in elections for the office of president was the person selected to be the president of UNIP by the party’s general conference. The second-ranking person in the Zambian hierarchy was UNIP’s secretary general.

Growing opposition to UNIP’s monopoly on power led to the rise in 1990 of the Movement for Multiparty Democracy (MMD). The MMD assembled an increasingly impressive group of important Zambians, including prominent UNIP defectors and labour leaders. In 1990, the president of Zambia (Kenneth Kaunda) agreed to a referendum on the one-party state but because of continued opposition dropped the referendum and signed a constitutional amendment making Zambia a multi-party state. Zambia’s first multi-party elections for parliament and the presidency since the 1960s were held on 31 October 1991, when MMD candidate Frederick Chiluba won the presidential election over Kenneth Kaunda.

The MMD remained in power until late 2011, when its presidential candidate, former President Banda, lost the presidential election to Michael Sata of the Patriotic Front (PF) party. When Michael Sata passed away on 28 October 2011, Vice President Guy Scott acted as the president until 25 January 2015, when Edgar Lungu, a PF member, was voted in as the
president. It made international headlines that Guy Scott became the first white president of an African country since Frederik Willem de Klerk of South Africa left in 1994.

On 20 October 2014, an article on CNN website, *Zambia’s Guy Scott makes history as white president in sub-Saharan Africa*, with video footage shown in Figure 1.2, stated that:

South African President Frederik de Klerk was the continent’s last white President. His party lost to Nelson Mandela’s African National Congress in South Africa’s first multiracial, fully democratic elections in 1994. (Karimi, 2014)

![Figure 1.2. Zambia’s Guy Scott makes history as white president in Sub-Saharan Africa](Source: CNN, 2014)

Edgar Lungu is the incumbent president of Zambia.

The Zambian government consists of three branches, namely, the Executive, the Legislature, and the Judiciary. These branches operate autonomously.

The Executive comprises an elected president and the Cabinet members he appoints from the elected and nominated members of parliament. Presidents serve terms of five years and are limited to two terms.

The judiciary hears civil and criminal matters and matters relating to, and in respect of, the Constitution. Section 122 (1) of the *Constitution of Zambia (Amendment) Act* (2016)
states that the Judiciary shall be subject only to the Constitution and the law, and not be subject
to the control or direction of a person or an authority.

The National Assembly, headed by the Speaker, is Zambia’s legislative body. The
current National Assembly has 166 members, with 158 members directly elected in single-
member constituencies using the simple first-past-the-post system. Nine additional seats are
filled by presidential appointment. The Vice President is also granted a seat in the assembly.
All members serve five-year terms.

Administratively, Zambia is divided into 10 provinces: Central, Copperbelt, Eastern,
Luapula, Lusaka, Muchinga, Northern, North-Western, Southern and Western. These provinces
are further subdivided into districts, constituencies and wards.

1.2.4 Socio-economic factors

This section presents an overview of some of the Zambian socio-economic.

Economic factors

Although Zambia has a mixed economy comprised of a rural agricultural sector and a
modern urban sector, the economy depends on copper and cobalt exports to generate most of
its foreign exchange revenue. As a result, “the country remains susceptible to the high risk of
external commodity price fluctuations” (CSO, 2015a, p. 1). For example, the copper mining
industry, between 1965 and 1975, accounted for 95 percent of annual export earnings and
contributed 45 percent of government revenue. In 2015, a decline in global demand for copper,
which accounts for approximately 70% of the country’s external revenue earnings, was among
the factors that dampened the prospects for economic growth in Zambia. In 2014, for example,
the construction sector contributed 14 percent of the gross domestic product (GDP), agriculture
9 percent, and the manufacturing sector and mining each contributed 8 percent (CSO, 2014)
The contribution of other sectors are not stated here.

Education indicators

The Zambian Central Statistical Office (CSO, 2015b) presented a summary of selected
economic indicators in its publication, Selected socioeconomic indicators report 2015.
Regarding education indicators for Zambia, CSO focussed on the literacy rate, school
attendance, highest level of education attained, student-teacher ratio, sex parity index, the number of teachers in all schools, and grade 12 school results. These are discussed below.

Literacy in Zambia

Table 1.1 shows the literacy rate by sex, rural/urban, province and age group from the 2007 and 2013-14 Zambia Demographic and Health Survey (CSO, 2015b).

Table 1.1 Literacy rate by residence and age group 2007-2013-14 (Adapted from CSO, 2015b, p. 18)

<table>
<thead>
<tr>
<th>Province/Residence/</th>
<th>Age Group</th>
<th>Males</th>
<th>Females</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15-19</td>
<td>83.5</td>
<td>73.3</td>
<td>82.3</td>
<td>78.8</td>
</tr>
<tr>
<td></td>
<td>20-24</td>
<td>81.0</td>
<td>61.0</td>
<td>88.6</td>
<td>75.4</td>
</tr>
<tr>
<td></td>
<td>25-29</td>
<td>79.1</td>
<td>64.3</td>
<td>81.0</td>
<td>63.2</td>
</tr>
<tr>
<td></td>
<td>30-34</td>
<td>80.5</td>
<td>56.2</td>
<td>80.4</td>
<td>60.4</td>
</tr>
<tr>
<td></td>
<td>35-39</td>
<td>79.9</td>
<td>59.1</td>
<td>80.3</td>
<td>58.7</td>
</tr>
<tr>
<td></td>
<td>40-44</td>
<td>84.4</td>
<td>64.3</td>
<td>82.6</td>
<td>60.4</td>
</tr>
<tr>
<td></td>
<td>45-49</td>
<td>83.1</td>
<td>60.7</td>
<td>81.5</td>
<td>60.5</td>
</tr>
</tbody>
</table>

Student-teacher ratios

For decades, Zambia has had very higher student-teacher ratio in both primary and secondary schools. Table 1.2 shows the student-teacher ratio in all schools by class range and province in 2014. At national level, Grade 1-4 had the highest ratio and Grade 8-9 had the lowest ratio. Generally, Luapula Province had the highest ratio for all grade ranges as shown in Table 1.2.
Table 1.2. Student-teacher ratio by year levels and province, Zambia 2014 (Source: CSO, 2015b)

<table>
<thead>
<tr>
<th>Province</th>
<th>Grade 1-4</th>
<th>Grade 5-7</th>
<th>Grade 1-7</th>
<th>Grade 1-9</th>
<th>Grade 8-9</th>
<th>Grade 10-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zambia</td>
<td>56.9</td>
<td>52.7</td>
<td>55.3</td>
<td>47.2</td>
<td>23.7</td>
<td>36.0</td>
</tr>
<tr>
<td>Central</td>
<td>55.1</td>
<td>50.6</td>
<td>53.4</td>
<td>45.3</td>
<td>22.8</td>
<td>31.1</td>
</tr>
<tr>
<td>Copperbelt</td>
<td>39.6</td>
<td>49.1</td>
<td>42.9</td>
<td>37.8</td>
<td>25.0</td>
<td>42.5</td>
</tr>
<tr>
<td>Eastern</td>
<td>73.3</td>
<td>55.2</td>
<td>66.1</td>
<td>58.3</td>
<td>28.6</td>
<td>32.0</td>
</tr>
<tr>
<td>Luapula</td>
<td>104.9</td>
<td>96.3</td>
<td>101.8</td>
<td>85.9</td>
<td>38.0</td>
<td>40.2</td>
</tr>
<tr>
<td>Lusaka</td>
<td>42.4</td>
<td>48.3</td>
<td>44.7</td>
<td>37.7</td>
<td>20.4</td>
<td>39.0</td>
</tr>
<tr>
<td>Muchinga</td>
<td>74.3</td>
<td>53.1</td>
<td>65.5</td>
<td>57.3</td>
<td>23.8</td>
<td>24.4</td>
</tr>
<tr>
<td>North-Western</td>
<td>59.5</td>
<td>46.9</td>
<td>54.6</td>
<td>46.7</td>
<td>24.6</td>
<td>38.8</td>
</tr>
<tr>
<td>Northern</td>
<td>74.6</td>
<td>53.3</td>
<td>66.0</td>
<td>54.6</td>
<td>14.4</td>
<td>26.7</td>
</tr>
<tr>
<td>Southern</td>
<td>53.5</td>
<td>53.9</td>
<td>53.6</td>
<td>45.0</td>
<td>21.9</td>
<td>31.7</td>
</tr>
<tr>
<td>Western</td>
<td>58.1</td>
<td>48.5</td>
<td>54.5</td>
<td>48.5</td>
<td>27.1</td>
<td>39.3</td>
</tr>
</tbody>
</table>

Percentage of candidates obtaining full Grade 12 school certificates in 2014

Table 1.3 shows the total number of candidates who sat for Grade 12 examinations and the percentage of those who obtained full School Certificates in 2014.

Table 1.3 Percentage of candidates obtaining full Grade 12 School Certificates in 2014
(Source: CSO, 2015b, p. 22)

<table>
<thead>
<tr>
<th>Province</th>
<th>Total</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zambia</td>
<td>119,962</td>
<td>66,039</td>
<td>53,173</td>
<td>66,371</td>
<td>39,992</td>
<td>27,079</td>
<td>56.5</td>
<td>56.5</td>
<td>56.5</td>
</tr>
<tr>
<td>Central</td>
<td>11,575</td>
<td>6,639</td>
<td>4,936</td>
<td>6,883</td>
<td>4,053</td>
<td>2,830</td>
<td>59.2</td>
<td>61.1</td>
<td>56.7</td>
</tr>
<tr>
<td>Copperbelt</td>
<td>31,955</td>
<td>16,971</td>
<td>15,524</td>
<td>14,316</td>
<td>7,752</td>
<td>6,564</td>
<td>45.9</td>
<td>47.4</td>
<td>45.3</td>
</tr>
<tr>
<td>Eastern</td>
<td>10,298</td>
<td>6,314</td>
<td>3,974</td>
<td>6,934</td>
<td>4,339</td>
<td>2,595</td>
<td>67.4</td>
<td>68.3</td>
<td>66.1</td>
</tr>
<tr>
<td>Luapula</td>
<td>5,983</td>
<td>3,924</td>
<td>2,059</td>
<td>3,407</td>
<td>2,230</td>
<td>1,177</td>
<td>56.6</td>
<td>56.8</td>
<td>48.3</td>
</tr>
<tr>
<td>Lusaka</td>
<td>25,194</td>
<td>12,239</td>
<td>12,954</td>
<td>15,132</td>
<td>8,381</td>
<td>6,751</td>
<td>61.3</td>
<td>63.4</td>
<td>58.9</td>
</tr>
<tr>
<td>Muchinga</td>
<td>4,389</td>
<td>2,712</td>
<td>1,677</td>
<td>2,795</td>
<td>1,775</td>
<td>1,020</td>
<td>65.7</td>
<td>65.5</td>
<td>66.8</td>
</tr>
<tr>
<td>North-Western</td>
<td>6,384</td>
<td>3,806</td>
<td>2,598</td>
<td>3,478</td>
<td>2,146</td>
<td>1,332</td>
<td>64.7</td>
<td>56.4</td>
<td>52.1</td>
</tr>
<tr>
<td>Northern</td>
<td>6,086</td>
<td>3,870</td>
<td>2,216</td>
<td>3,121</td>
<td>2,013</td>
<td>1,108</td>
<td>51.7</td>
<td>54.9</td>
<td>46.8</td>
</tr>
<tr>
<td>Southern</td>
<td>12,384</td>
<td>6,839</td>
<td>5,545</td>
<td>8,028</td>
<td>4,647</td>
<td>3,381</td>
<td>66.4</td>
<td>67.5</td>
<td>65.0</td>
</tr>
<tr>
<td>Western</td>
<td>5,675</td>
<td>3,178</td>
<td>2,497</td>
<td>2,907</td>
<td>1,896</td>
<td>1,011</td>
<td>51.2</td>
<td>53.4</td>
<td>48.5</td>
</tr>
</tbody>
</table>

As can be seen in Table 1.3 a higher percentage of boys obtained school certificates than girls. Overall, Eastern Province had the highest percentage of candidates who obtained full
school certificates while Copperbelt Province had the lowest percentage.

1.3 The Zambian education system

The Glossary of Education Reform (2014) describes a country’s education system as including everything that relates to educating public school students at the federal, state, or community level: laws, policies, and regulations; public funding, resource allocations, and procedures for determining funding; state and district administrative offices, schools facilities, and transportation vehicles; human resources, staffing, contracts, compensation, and employee benefits; books, computers, teaching resources, and other learning materials; and countless other contributing elements.

In Zambia, the Education Act of 1966, with its various statutory instruments, and the National Policy on Education (Educating Our Future) of 1996 empowers the Zambia Ministry of Education (MOE) to guide the provision of education for all Zambians. The vision of MOE is stated as “Quality, lifelong education for all which is accessible, inclusive and relevant to the individual, national and global needs and value system” (MOE, 2014).

1.3.1 Structure of the education system

In terms of its structure, the Minister of Education, assisted by the Deputy Minister, heads the Ministry. The Permanent Secretary is the highest civil service position of the Ministry. The Ministry has seven directorates, as shown in Figure 1.3.
The Ministry of Education has ten provincial offices, each headed by a Provincial Education Officer (PEO). Altogether, there are 89 school districts in Zambia, each headed by a District Education Board Secretary (DEBS) (MOE, 2014).

The Minister has full responsibility for all the sixteen government colleges of teacher education, but limited responsibility (financial and supervisory) for the four public universities (MOE, 2014).

Schooling in Zambia consists of seven years of primary schooling and five years of secondary schooling before students can enter university, college, or other institutions of higher learning. The academic year in Zambia runs from January to December. There are three terms in a year with each term lasting for three months. School holidays between terms last about 30 days, so that each school year has approximately 40 weeks.

The progression through primary and secondary education is controlled by three national examinations, held at the end of Grade 7, Grade 9 and Grade 12, and prepared and marked by the Examination Council of Zambia (ECZ). Those who fail exams either repeat (if they failed by a small margin) or drop out of school completely.

The minimum entrance age to the first year of primary school is seven years. Therefore, a student is expected to enter the first year of high school (Grade 8) at 14 years of age. However, the age limit is not rigid, especially at private schools, where entry is usually based on the performance of each student. It is, therefore, common to find students of varying age throughout the schooling years.

From the time Zambia gained its independence from Britain, English was the language of instruction in schools. However, in 2013, the Ministry published the National Guide for the language of instruction practice, mandating that Zambian languages replace English as a medium of instruction in Grades 1 to 4 in all primary schools in the nation (MESVTEE, 2003).

1.3.2 Challenges to education in Zambia

The system is not without challenges, with some of those explicitly stated on the official website of the Ministry (MOE, 2014) worth noting. The Planning and Information Directorate in MOE is not well co-ordinated with the provincial and district offices. Therefore,
the vital statistics on students, enrolment rates, dropout rates, teachers, and educational materials are not up to date and sometimes not accurate. This challenge is compounded by having very few well-trained staff in planning, statistics, and information management at the different levels of the Ministry. The flow of information from the Ministry to the community is weak and Ministry staff lack training to conduct valid analyses and co-ordinate dissemination of policy guidelines from the Ministry to the public (MOE, 2014).

Another challenge is that the understaffed Standards and Evaluation section fails to conduct frequent field inspections to ensure compliance with educational standards (MOE, 2014). In addition, the section has not been providing regular professional encouragement, guidance and counselling to teachers through visits to schools and arranging in-service training courses for teachers (MOE, 2014). A further challenge is that the shortages in staff at the Curriculum Development section has hindered the curriculum-related research and, therefore, no constant advice on curriculum policy is given to the Ministry (MOE, 2014). Another notable challenge is that teacher education training functions and placement are spread among many departments in the Ministry, making accountability difficult and implementation of teacher education programmes less effective (MOE, 2014).

In addition, continuing and distance education has faced serious problems of under-funding, inadequately trained personnel, and insufficient materials for learning and teaching (MOE, 2014).

Constraints to School-Based Continuing Professional Development (SBCPD) implementation in Zambian schools from 2006 to 2010 identified by the Ministry included the shortage of time for teachers to prepare lesson plans and SBCPD cycles; an insufficient number of mathematics and science teachers; an increase in the number of students; and the need for afternoon classes of Academic Production Unit (APU), which imposed large workloads on science teachers. The ministry stated that the relatively high workload of science and mathematics teachers (28 class periods per week) was due to a severe teacher shortage in these subjects (MOE, 2010).

The limited number of qualified teachers of science and mathematics in several schools hinder departmental meetings within these subject areas (MOE, 2010). Reasons for limited numbers of teachers in remote and rural areas in Zambia include the lack of electricity, suitable buildings, drinking water, and satisfactory living conditions including accommodation for
teachers (MOE, 2006). What is provided to teachers “as a hardship allowance is not compensation enough for the hardships they must endure in life in these difficult locations” (MOE, 2006, p. 12). Many of these schools are distant from the main roads and markets, and teachers must walk the whole way to obtain their supplies. Some rural communities have tried to mitigate teachers’ hardships by providing teachers with accommodation and assisting them in securing consumption needs by securing the supplies from markets in the vicinity and making them available. However, “the majority of the communities do not offer schools the needed assistance” (MOE, 2006, p. 13). These challenges in rural schools may not inspire teachers to work there.

Furthermore, schools may have a limited number of teachers because of the delays in the teacher recruitment process. The Ministry of Education states, “Currently, there is considerable delay in the recruitment and appointment of teachers. Sometimes, it takes as long as 2-3 years for many teachers to get appointed after completing their training” (MOE, 2006, p. 12). The Ministry of Education stated it would consider how best the recruitments processes could be streamlined to make it more efficient and cut possible delays.

Another challenge schools face is inadequate materials and necessary information for teachers to use as tools to improve their competence (MOE, 2010). There are insufficient teaching and learning resources and internet facilities in many schools in Zambia, especially in rural areas. The Ministry of Education requires schools to implement countermeasures such as maximising the use of available resources; making improvised teaching materials with locally available resources; and procuring more materials with funds from income generating activities within a school.

Considering the above challenges, questions may be raised regarding the effectiveness of teaching and learning in Zambian schools.

### 1.4 Student performance in mathematics in Zambia

Persistent poor student performance in mathematics, especially at Grade 7 and Grade 12 national examinations, is a significant issue that has dominated parliamentary, public, and scholarly debate in Zambia. Nation-wide surveys have consistently reported unsatisfactory results in mathematics since the 1970s (Henderson & Sharma, 1974; Kelly, 1991; Ministry of
Education, 1996). For example, a survey of numeracy achievement at Grade 3 level in Zambia by Henderson and Sharma (1974) reported that students failed to master the numeracy skills expected at their grade level. Thirty-five years after the survey by Henderson and Sharma, Professor Lungwangwa, while holding the office of Minister of Education in Zambia, reported:

As a nation, we cannot lag behind in Mathematics, Science and Technology because these subjects are cardinal to national development. Statistics indicate that 40 percent of children who sat for last year’s [2008] school certificate examination failed mathematics. (Lungwangwa, as quoted by Lusaka Times, March 28, 2009)

Lungwangwa further implored all colleges of education as well as the entire Ministry of Education to devise and implement strategies to address poor performances in mathematics, science, and technology.

The correct question to ask before considering the strategies for addressing poor student performance relates to the explanatory variables, or causes, for persistent poor student performance in mathematics.

The MOE, and some educators, such as Kelly (1991), have blamed the poor student performance in mathematics in Zambia on a number of factors. The MOE situated the blame as follows:

This distressing picture of poor in-school performance in mathematics and science and subsequent inadequacy in these areas points to deficiencies at the school level. The deficiency may be in the facilities, the resources or the teaching. It may be in the balance of the curriculum. It may be in the expectations that students set for themselves and that others entertain for them since these are known to have a major impact on student performance. (MOE, 1996, p. 53)

Kelly (1991) on the other hand, blames the poor student performance in mathematics on the use of a foreign language, English. He argued that students failed to learn mathematical concepts that were taught using a language a student could not fully understand. Kelly further questioned the effectiveness of the training that teachers receive.

The commitment by the Zambian government to address the poor student performance in mathematics is well documented. For example, MOE affirmed that persistent poor in-school performance in mathematics and science in schools is a situation that
requires urgent attention and major interventions. The students themselves and the
country as a whole cannot sustain a continuation of this unsatisfactory performance
in mathematics and science, leading to an equally unsatisfactory performance in the
School Certificate as a whole and subsequent impairment of the national potential for
technological development. (MOE, 1996, p. 53)

In addition, the former Minister of Education, Lungwangwa, after lamenting the poor
performance of students in mathematics, science and technology, stated, “It is incumbent on the
colleges as well as the entire Ministry to come up with strategies that will address poor
performances in the three subjects” (Lungwangwa, as quoted by Lusaka Times, March 28,
2009).

1.5 Mathematics education reforms in Zambia

Mathematics education has undergone several reform attempts since Zambia’s
political independence in 1964. As already pointed out in the previous section, mathematics,
science, and technology are seen as important subjects for national development. The Ministry
of Education, many educators, and teachers of mathematics, have identified three primary areas
of mathematics education that require reform: teacher-centred instruction, the mathematics
curriculum, and continuing professional development of mathematics teachers (MOE, 1996).

1.5.1 Instruction

In 1996, the Ministry of Education adopted the philosophy that the education process
must centre on the “pupil who has an active role to play in developing his or her intellectual and
other qualities” (MOE, 1996, p. 44), and challenged every school in Zambia to transform
teacher-centred instruction into problem-centred interactive instruction, with an emphasis on
student group-work, projects, and guided discovery. To meet this challenge, MOE (1996)
committed itself to “enrich the learning environment in each classroom with suitable materials,
as well as with facilities for the display of pupil work” (p. 41).

Thirteen years later, MOE reported a gap between the “leaner-centred-approach”
emphasised in the 1996 National Policy on Education and mathematics classroom practice in
2009. Most of the lessons were still conducted as traditional “chalk and talk”. To that effect,
MOE admitted the challenge it faced:

The challenge we have now is to help the teachers and educators realize the need to develop their teaching strategies, which will uphold the policy. More emphasis of the goal and mission is put on the learners to take responsibility for their own learning. A teacher is challenged to develop a reflective approach and align their lessons with the goals of the Ministry of Education. At every moment, we need to ask ourselves what it is we are developing in the mind of the learners and for what use. (MOE, 2009, p viii)

The efforts of the MOE to help teachers understand the meaning of student-centred learning can be seen its two publications *A Teacher’s Guide for School-Based Continuing Professional Development* (MOE, 2007) and *School-Based Continuing Professional Development (SBCPD)* Through Lesson Study – *Teaching Skills Book* (MOE, 2009). The latter manual, for example, is aimed at making teachers and educators understand and develop learner-centred lessons (MOE, 2009, p. viii).

However, the question that remains is whether the two publications have helped transform mathematics classroom instruction from “chalk and talk” to “student-centred”.

### 1.5.2 The mathematics curriculum

The Government of Zambia through the MOE makes decisions concerning curriculum issues at the national level while the Curriculum Development Centre and the Examinations Council of Zambia implement these decisions.

Regarding the reforms in the mathematics curriculum, in the early 1990s, the Government decided to localize the Grades 10 to 12 curricula. Until that time, mathematics and many other subjects for Grades 10 to 12 were based on syllabi prepared at Cambridge in the UK. In addition, students sat for mathematics examinations set and marked in the UK. To facilitate the localisation of the syllabi a Subject Technical Curriculum Committee was set up by the Curriculum Development Centre for each subject, and a development team for each was constituted to develop the syllabus in that subject. Draft syllabi were first sent to various educational institutions such as universities and colleges for their input before being presented to the Technical Curriculum Committee for each subject. The Curriculum Development Centre
through writing teams used approved syllabi as guidelines for producing student textbooks and teachers’ guides. The materials developed were evaluated through an internal evaluation system in the evaluation department at the Curriculum Development Centre. The syllabi and instructional materials were distributed to schools, and examinations were based on the localised syllabi.

In 1996, the MOE committed itself to overhaul the curriculum for lower, middle, and upper primary schools, as well as for junior secondary and high schools, stating that:

Specifically, the Ministry would, through the Curriculum Development Centre, overhaul curriculum for lower and middle basic education to promote skills in numeracy, mathematics and science; the curriculum for upper basic education, to promote high levels of competence in communication and mathematical skills, and to strengthen the foundation for Grade 8 and 9 education; and the curriculum for high schools, to concentrate efforts on improving achievement in mathematics and science. (MOE, 1996, pp. 46-53)

Several efforts by MOE to reform the curriculum in mathematics and other subjects have been reported from 1998 to 2014 (MOE, 2014). The 2003-2007 Strategic Plan for MOE, for example, sought to reform the curriculum at basic, high school and tertiary levels in order to provide relevant skills and knowledge, and sufficient learning and teaching materials for all levels (MOE, 2003). Notably, in 2007 MOE reported having revised the curriculum for Basic Education (MOE, 2014).

A remarkable sign of the effort towards the curriculum reform is that by 2007, MOE had already carried out some training on the new curriculum for Grade 1 teachers. The old curriculum was teacher-centred focussing on the teacher finishing the syllabus, and had limited learner-teacher contact. Furthermore, it stated whole class instruction time, used English as the sole language of instruction, had single assessments through an examination, and emphasised factual information and rote learning. On the other hand, the new curriculum required the teacher to ensure each student’s success, was learner-centred, increased learner-teacher contact time, ensured students learned at their own pace, advocated the use of familiar language for initial literacy, adopted continuous assessment methods, and stressed the relationships with other subjects (MOE, 2007).
In 2013, the Ministry of Education revised the curriculum for secondary education and implemented it in January 2014 (MOE, 2014). The new curriculum has brought about two career paths for students, namely the vocational and professional paths. The vocational path allows students entering Grade 10 to pursue vocational subjects such as electrical studies to Grade 12. The students may enter the workforce after completing the Grade 12. The professional path allows the student to pursue subjects such as science, economics, and psychology, so that they enter colleges and universities after completing Grade 12.

1.5.3 Continuing teacher professional development

Continuing teacher professional development (CPD), according to MOE, is required because “a teacher’s professional life revolves around two areas of never-ending growth and progression: knowledge, which is always increasing and changing; and children, each one unique and developing within the fabric of a changing social environment” (MOE, 1996, p. 105). On the one hand, MOE has been creating structures and programmes that provide teachers with an opportunity to continue to grow as professionals. On the other hand, teachers have “a responsibility, to themselves and to their profession, to deepen their knowledge, extend their professional skills, and keep themselves up-to-date on major developments affecting their profession” (MOE, 1996, p. 105).

There are several examples of the opportunities for teacher professional development created by MOE. The MOE established the School Programme for In-service Training (SPRINT) in 1998 as a structure for SBCPD, targeting all schools offering primary and secondary education. The aim of SPRINT is to ensure that all those who teach the same grades or subjects to meet regularly (Baba & Nakai, 2011). MOE states that SPRINT is “one of the effective ways of improving education as far as teaching is concerned as it targets self-development, group and eventually institutional development” (MOE, 2009, p. iii). However, MOE has noted that “while the structures of CPD appear to be well developed the efficacy of the structure in improving teaching and learning is weak” (MOE, 2011, p. 37). This statement resonates strongly with the observation made by Baba and Nakai (2011) that “the purpose and method of such [SPRINT] meetings were not clear” (p. 58).

Since 1996, MOE has also been releasing large numbers of teachers who hold certificates and diplomas in mathematics for full-time university studies. Moreover, MOE has
created Teacher Resource Centres (TRC); each of the ten provinces has a provincial resource centre, and there is at least one resource centre in each of the 89 districts in Zambia.

Another effort by MOE is the development of a *Curriculum Manual* and a *Mathematics Rainbow Kit, MARK: Teachers’ Guide* in 2004. The two publications are aimed at guiding mathematics teachers to help their students develop numeracy skills in primary schools. MOE has introduced the Education Leadership and Management training programme to strengthen effective school management. Headteachers and other staff at different management levels within MOE attend this programme (MOE, 2011). The implication for teaching mathematics is that effective school administrators are such as to provide incentives for teacher growth.

Furthermore, the Japanese International Cooperation Agency (JICA) helped the Ministry to implement a programme called Strengthening Mathematics, Science and Technology Education (SMASTE) School-based CPD through lesson study in 2005.

### 1.6 Introduction of lesson study in Zambia

The introduction of lesson study in Zambia is credited to the co-operation between the Japanese International Cooperation Agency (JICA) and African countries, which first started in Kenya in 1998 through the *Strengthening Mathematics and Science at Secondary Education* (SMASSE) project. This project focused on lesson improvement through teacher training. When the benefits of the SMASSE project in Kenya became evident, some African countries in 2003 (shown in Table 1.4) decided to co-operate with JICA. Having a growing desire for sharing their experiences in, and knowledge of, mathematics and science education, the countries decided to form a network called *Strengthening of Mathematics and Science Education in Western, Eastern, Central, and Southern Africa* (SMASE-WECSA) (Ishihara, 2012). The SMASE-WECSA network is “a platform under which mathematics and science educators across Africa can share and create practical wisdom through the exchange of each country’s experiences and knowledge in mathematics and science” (Ishihara, 2012, p. 4). SMASE-WECSA can be conceived of as a community of practice, which Wenger, McDermott, and Snyder (2002) define as a group of people who share a concern, a set of problems, or passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an
ongoing basis.

Among the concerns the member countries have shared, are the two major challenges they faced in mathematics and science as reported by JICA (2012). The first challenge is the persistent poor student performance in mathematics and science. This challenge, according to JICA, might cause many African countries not to develop human resources that promote science and technology. The other challenge is the persistent inadequate teaching skills and teacher-centred lecture style model, *ceteris paribus*, which continues to perpetuate poor student performance in mathematics and science (JICA, 2012).

<table>
<thead>
<tr>
<th>Year joined SMASE-WECSA</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>Rwanda, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe</td>
</tr>
<tr>
<td>2004</td>
<td>Botswana, Burundi, Niger, Nigeria</td>
</tr>
<tr>
<td>2005</td>
<td>Senegal</td>
</tr>
<tr>
<td>2006</td>
<td>Cameroon, Ethiopia, Sierra Leone</td>
</tr>
<tr>
<td>2007</td>
<td>Burkina Faso, Gambia, Zanzibar</td>
</tr>
<tr>
<td>2008</td>
<td>Angola, Southern Sudan</td>
</tr>
<tr>
<td>2010</td>
<td>Mali</td>
</tr>
<tr>
<td>2011</td>
<td>Benin, Namibia</td>
</tr>
</tbody>
</table>

As can be seen in Table 1.4, Zambia was among the 11 original member countries that initiated SMASE-WECSA.

While a member of SMASE-WECSA, Zambia started introducing lesson study into teachers’ meetings held under SPRINT in 2005 (MOE, 2011). Lesson study was introduced in schools under the JICA supported SMASTE project. The SMASTE project was implemented in three phases. Phase one covered schools in the Central Province. Phase two covered schools in two provinces, Copperbelt Province and Northwestern Province. Phase three was implemented in 2011 under a new project name, Strengthening Teacher’s Performance and Skills (STEPS), through SBCPD. Phase three targeted all ten provinces of Zambia and it was anticipated that more than 72,000 teachers across the country would benefit from STEPS (Embassy of Japanese in Zambia, 2014).

The MOE (2009) described lesson study as “One of the effective ways of improving
education … as it targets [teacher] self-development, group, and eventually the institutional [school] development” (p. iii). Similarly, Baba and Nakai (2011) stated that the MOE implemented lesson study to improve teaching competence, nurture an awareness of teachers’ responsibility and pride as a professional, and to revitalise the institution.

According to Baba and Nakai (2011), lesson study practice in Zambia involves the teachers forming a group according to subject or grade level and conducting a cycle of lesson study every month. Furthermore, a workshop for school administration should be held during school holidays to reflect on the lesson study in the previous school term and to plan for the coming term through sharing information. The district and provincial education officers sometimes set the theme for schools within the area.

The introduction of lesson study in Zambia had profound implications for member countries of the SMASE-WECSA network. Ishihara (2012), for example, reported that in October 2008 Uganda was interested in school-based training through lesson study in Zambia, and finally “developed training contents and materials on lesson study in 2009 by referring to Zambian experiences” (p. 94). Similarly, in 2008 Swaziland approached Zambia regarding technical workshops, resulting in the first official SMASE-WECSA Technical Workshop in May 2009 in Swaziland, attended by 97 participants from 15 different countries including three Asian countries – Malaysia, the Philippines and Japan. Ishihara noted that Kenyan and Zambian experts organized and facilitated the whole workshop, using their experiences in their countries.
Chapter 2 Literature review

This chapter presents a review of the literature on teacher professional development, Japanese Lesson Study, the Japanese structured problem-solving approach, and the adoption and adaptation of lesson study in non-Japanese countries, leading to a statement of the research questions and the significance of the research.

2.1 Teacher professional development

Teacher professional development is a subject that has been studied widely. The foci of the studies have varied. Areas that have been studied include designs of professional development (for example, Birman, Desimone, Porter & Garet, 2000; Loucks-Horsley, Stiles, Mundry & Hewson 2010; Darling-Hammond, Wei, Andree, Richardson & Orphanos, 2009); the effects of professional development (Cohen, Hill & Kennedy, 2002; Desimone, Porter, Garet, Yoon & Birman, 2002); and policies on professional development (Dutro, Fisk, Koch, Roop & Wixson, 2002; Knapp, 2003).

2.1.1 Definition of professional development

While there seems to be no universal definition of professional development, most definitions given by scholars refer to “both formal and informal learning experiences and processes that lead to deepened understanding and improvement of practice” (Broad & Evans, 2006, p. 3). Some definitions emphasise teachers’ continuous professional learning within the wider context of change and its interrelated features (Beard, 2007; Carpenter & Stimpson, 2007). Some definitions are as descriptive as possible (Fullan, 2007; Knapp, 2003; Meiers & Ingvarson, 2005; Timperley, Wilson, Barrar & Fung, 2007), with Day (1999) providing the following definition:

Professional development consists of all natural learning experiences and those conscious and planned activities which are intended to be of direct or indirect benefit to the individual, group or school, which contribute, through these, to the quality of education in the classroom. It is the process by which, alone and with others, teachers
review, renew and extend their commitment as change agents to the moral purpose of teaching; and by which they acquire and develop critically the knowledge, skills and emotional intelligence essential to good professional thinking, planning and practice with children, young people and colleagues throughout each phase of their teaching lives. (p. 4)

Scholars, such as Darling-Hammond, Wei, Andree, Richardson, and Orphanos (2009), emphasise the need for high-quality professional development, which they define as the type of development that “results in improvements in teachers’ knowledge and instructional practice, as well as improved student learning” (p. 3).

While there may be many definitions, the question is how best a clear and deep understanding of professional development can be gained from the scholarly debate. Borko (2004), for example, proposes focusing on what she calls the four key elements of any professional development system. These elements are the professional development programme; teachers, who are the learners in the system; the facilitator, who guides teachers as they construct new knowledge and practices; and the context in which the professional development occurs (p. 5).

2.1.2 The one-size-fits-all approach to professional development

Some scholars have argued that the one-size-fits-all approach to professional development is not effective, partly because of the differences in settings where professional development takes place (for example, Hargreaves, Berry, Lai, Leung, Scott & Stobart, 2013; Flowers, Mertens & Mulhall, 2003; Lieberman, 1995). Guskey (2003), for example, analysed lists of characteristics of effective professional development to promote visionary leadership, and found that the “differences in communities of school administrators, teachers, and students uniquely affect professional development processes and can strongly influence the characteristics that contribute to professional development’s effectiveness” (p. 47). Similarly, Flowers, Mertens, and Mulhall (2003) examined the professional development activities and needs of middle grade teachers. They reported that the “one size fits all” approach to professional development is problematic, stressing that it needs to be examined from differing perspectives such as school administrator versus teacher, and recommended the disaggregation of professional development data to provide more detailed information about varying needs of...
sub-groups of teachers.

2.2 Focus of this study

In Zambia, the Ministry of Education introduced lesson study in all government schools to help reforming three primary areas of mathematics education: teacher-centred instruction, the mathematics curriculum, and continuing professional development of mathematics teachers. To do so, teachers of mathematics in Zambian schools needed to embrace the critical features of lesson study, including the recommendations stated in the Ministry policy documents on lesson study.

There had been increased interest in research on the institutionalisation of lesson study in Zambia, with a number of publications among which is an article by Baba and Nakai (2011), *Teachers’ institution and participation in a lesson study project in Zambia: Implication and possibilities*. Research on the implementation of lesson study, taking Zambia as a case, for example, is important because the research findings may have significant implications for lesson study in Zambia and other countries, including member states of SMASE-WECSA. Indeed, lack of such research would be a serious omission, particularly given the fact that studies on the adaptation of Japanese Lesson Study are not mere issues of empirical interest, but issues that have significant policy implications, significant bearing on the professional development of teachers and, indirectly, the economy of a nation. The Government of the Republic of Zambia, for example, states that the skills students get in mathematics play a critical role in the country’s socio-economic development (Zambia Ministry of Finance and National Planning, 2011, p. 91).

More research on the implementation of lesson study in various countries is needed to deepen our understanding and share the lessons from these implementations. Therefore, research on the implementation of lesson study in mathematics, taking the case of Zambia, is timely.
2.2.1 Key characteristics of high-quality professional development

Research on professional development stresses sustained and well-designed, high-quality teacher professional development programmes. As Wei, Darling-Hammond, and Adamson (2010, p. 1) stated, “Professional development that is short, episodic, and disconnected from practice has little impact, [while] well-designed professional development can improve teaching practice and student achievement”. High-quality professional development, according to some researchers and policymakers, has several key characteristics that can improve teacher knowledge and practice, and student achievement (Birman et al., 2000; Cohen et al., 2002; Garet et al., 2010; Guskey, 2003; Kedzior & Fifield, 2004; King & Newmann, 2000; Wei et al., 2010). The key characteristics of high-quality professional development are summarised in Table 2.1.

Table 2.1. Summary of key characteristics of high-quality professional development

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content-focussed</td>
<td>Considers students’ prior knowledge related to the content, and strategies teachers can use to actively engage students in developing new understandings</td>
</tr>
<tr>
<td>Extended</td>
<td>Extended professional development experiences, allow for more substantive engagement with subject matter, more opportunities for active learning, and the development of coherent connections to teachers’ daily work</td>
</tr>
<tr>
<td>Collaborative</td>
<td>Teacher collaboration promotes teacher-learning and promotes activities consistent with teachers’ other experiences;</td>
</tr>
<tr>
<td>Part of daily work</td>
<td>Professional development should be largely school-based and incorporated into the day-to-day work of teachers.</td>
</tr>
<tr>
<td>Continuing</td>
<td>Professional development should be continuous, not episodic, and include follow-up and support for further learning.</td>
</tr>
<tr>
<td>Inquiry-based</td>
<td>Professional development should promote continuous inquiry and reflection through active learning</td>
</tr>
<tr>
<td>Coherent and integrated</td>
<td>Professional development should incorporate experiences that are consistent with teachers’ goals; aligned with standards, assessments, and other reform initiatives; and informed by the best available research evidence</td>
</tr>
<tr>
<td>Teacher-driven</td>
<td>Professional development should respond to teachers’ self-identified needs and interests to allow teachers to exercise ownership of its content and process.</td>
</tr>
</tbody>
</table>
Professional development should be informed by analyses of its impact on student performance.

Professional development should incorporate procedures for teacher self-evaluation of their efforts.

Guskey (2002) used the key characteristics of high-quality professional development to develop a five-level framework for assessing professional development activities. The levels of his framework are:

1. Participants’ reactions – personal responses as to how they felt about the day or activity.
2. Participants’ learning – did the participants feel they had developed adequate knowledge and skills through the activity?
3. Organisation support and change – was the activity supported with implementation strategies and resources?
4. Participants’ use of new knowledge and skills – did they apply this learning to their school context?
5. Student learning outcomes – what was the impact of the professional learning activity on student learning or associated outcomes? (Guskey, 2002, pp. 5-7)

Guskey (2002) stated that effective teacher professional development programmes are the ones designed to address all five levels. His framework has been used widely (see, for example, Berkvens, Kalyanpur, Kuiper & Van den Akker, 2012; White & Southwell, 2003), with the Australian Department of Education and Training for the Northern Territory Government, for example, using it as a basis for its development guidelines for evaluating profession learning in schools. The Department contends that all the five levels should be used:

All too often we address only the first two of these five levels – probably a legacy of the “one stop” workshop approach to professional learning. If professional learning is to be on going, sustained and client focussed, it follows that evaluation must be structured accordingly. (Department of Education and Training for the Northern Territory Government, 2014, p. 1)

The key characteristics of high-quality teacher professional development should be the foundations for frameworks for designing and evaluating teacher professional development
activities. Even when the key characteristics of high-quality teacher professional development are used as foundations, the question that still needs answers is how best to deal with barriers to implementation of effective professional development.

2.2.2 Barriers to effectiveness of teacher professional development

The literature has noted several barriers to teacher professional development. Among these are school contextual barriers (Kedzior & Fifield, 2004; Ebaeguin & Stephens, 2015; Villegas-Reimers & Reimers, 2000) and teacher personality barriers (Richardson, 1996). School contextual barriers, as noted by Villegas-Reimers and Reimers (2000), include the type of class the teacher teaches, the teacher’s colleagues, the head of the mathematics department, the school culture, the school leadership, school policies, and time and financial resources. According to Imants (2003), the social context of the school, to a considerable extent, promotes or hinders teacher professional development.

Following their analysis of current literature on lesson study, Ebaeguin and Stephens (2015) identified two approaches to implementation of lesson study outside Japan – the fidelity approach and the culturally embedded approach. They state that both approaches recognise the potential of lesson study for effecting teacher growth and quality teaching. They explain that a fidelity approach tends to start by asking what skills and knowledge teachers need to implement lesson study faithfully, whereas a culturally embedded approach, asks first what existing habits and values teachers have in a particular school that may hinder or support the implementation of lesson study. They argue against fidelity approach, stating that it treats lesson study “as just another program[me] or ‘package’ to be copied and not ways of thinking and habits that support good teaching and professional learning” (Ebaeguin & Stephens, 2015, p. 377). They cite Watanabe, Takahashi, and Yoshida (2008) and conclude that fidelity approach is likely to lead to further misunderstanding of lesson study. Further to this, they state that when lesson study is transferred and implemented into a different national context without considering possible cultural barriers there might be delays in reaping its benefits, if not the wastage of time, effort, and resources of its stakeholders.

Similar barriers have been highlighted in a study Creating Effective Teaching and Learning Environments: First Results from TALIS commissioned by the Organisation for Economic Co-operation and Development (OECD, 2009). The survey aimed to provide
quantitative, policy-relevant information on the teaching and learning environment in schools in 23 countries, focusing on lower secondary education. To understand better the participation in professional development and provide insight into potential policy levers, TALIS asked teachers who desired more professional development to specify the reasons that best explained what had prevented them from participating in more professional development activities. Across the participating countries, the most commonly cited of the six response options were “Conflict with work schedule” (47% of teachers) and “No suitable professional development” (42%).

2.2.3 The role of policy on professional development

Darling-Hammond and McLaughlin (1995) analysed policies that support professional development reform and argued that policymakers need to rethink ways in which schools are staffed, funded, and managed to provide enough time for teachers to undertake professional development.

Overall, policy plays a significant role in shaping teacher professional development. In turn, the outcome of research on teacher professional development can inform policy reforms. In this vein, Sykes (1996, cited by Borko, 2004), for example, viewed the insufficiency of standard professional development as the most serious unsolved problem for policy and practice in USA education. Also, one of the conclusions by Wei et al. (2010) in Phase II of a three-phase study on Professional Development in the United States: Trends and Challenges, was that

States and districts should reshape their policies and strategies related to professional development and instructional improvement to reduce their investment in less effective, short-term approaches and to support teachers’ engagement in the kinds of sustained professional development that research shows are more effective. (p. 42)

2.2.4 Implications for this research

The literature on teacher professional development has identified key characteristics of high-quality professional development, stated the role of policy on professional development, and noted some of the barriers to professional development. As will be discussed in the next section of this chapter, lesson study, the focus of this research, would appear to incorporate the
2.3 Japanese Lesson Study

The origins of lesson study in Japan can be traced back to the Meiji period (Baba 2007; Isoda, 2007; Makinae, 2010). In 1868 the Tokugawa shôgun (great general), who ruled Japan in the feudal period, lost his power and Emperor Meiji was restored to the supreme position. The Meiji restoration resulted in major political, economic, and social change that modernised and Westernised Japan. The Meiji government took profound steps to Westernise the Japanese education system.

In 1872, the Meiji government issued the Education Code and established a teachers’ school, the (Tokyo) Normal School, which later became the University of Tsukuba. In 1873, the Attached Elementary School was established (Isoda, 2007). The Meiji government invited foreign teachers to teach Western subjects, during which they introduced the concept of whole class instruction, whereas teachers and students were familiar only with the individualized instruction model during the Edo period. Therefore, the concept of whole class instruction, according to Isoda (2007), helped Japanese students learn not only the content of the subject, but also the methods of teaching by observing their teachers’ behaviour. In 1873, the Ministry of Education used the Normal School to publish the Teacher’s Canon, which stated the protocol for entering the classroom, observing the lessons, and avoiding the negative effects of observations.

Makinae (2010) states that the *object lesson* was introduced as a new teaching method and pre-service teachers in Normal schools would practise the object lesson by using the *criticism lesson*. This involved each student teaching a lesson to his, or her, group, while the class observed. After that, the class expressed its views on the different points of the lesson where they thought the teacher had succeeded or failed. Makinae (2010) states further that the introduction of the object lesson and the expansion of the criticism lesson from pre-service teacher training to in-service professional development describes how lesson study originated in Japan.

Since its introduction, lesson study has spread within Japan as “a process in which teachers progressively strive to improve their teaching methods by working with other teachers...
to examine and critique one another’s teaching techniques” (Baba & Nakai, 2011, p. 2). By the middle of the 1960s, lesson study in Japan was well-instituted as a strategy for in-service teacher training (Fernandez & Yoshida, 2004).

The phases of Japanese Lesson Study are well documented by many scholars and educators (Doig & Groves, 2011; Fernandez & Yoshida, 2004; Lewis, 2002a; Murata, 2011), with models for Japanese Lesson Study often identifying four phases, as shown in Figure 2.1.

Lewis (2002a) noted that in order to have a deep understanding and appreciation of the Japanese Lesson Study cycle, the four phases of lesson study need to be explored in depth. Similarly, Doig and Groves (2011) stated that each of the four phases requires a great deal of unpacking to “fully understand the concepts and processes of Japanese Lesson Study in practice” (p. 80).

The literature has identified what is critical under each of the four phases that make
Japanese Lesson Study stand out from other teacher professional development approaches. These features of each phase are discussed below.

Phase 1: Study curriculum and formulate goals

During Phase 1, the school and the lesson study group consider the long-term goals for student learning and development and determine and focus on a particular research goal (Ebaeguin & Stephens, 2014a, 2014b; Doig & Groves, 2011; Lewis, 2000; Lewis & Hurd, 2011; Lewis & Tsuchida, 1998), with Doig and Groves (2011) stating that a fundamental principle guiding the goal, or theme, setting is to address the gap between the qualities students have and the ideal of their teachers. In this vein, Lewis (2000) stated that selecting such a theme, or goal, is necessary for the success of lesson study and can lead to a research focus that can be sustained for many years. However, Doig and Groves (2011) argue that this “aspect of lesson study is often overlooked when it is adopted in other countries” (p. 80).

The long-term goals of Japanese Lesson Study may be about behaviour or attitude (Doig & Groves, 2011) and are usually “broader goals (site-based, practice-oriented [sic], collaborative, and centred on school-aged children’s learning) … [and may] remain the same across … contexts” (Yu, 2011, p. 125). Typical examples of goals given by Fernandez and Yoshida (2004) are: “Using a Japanese language class to foster students’ ability to wrestle with topics they discover on their own” and “developing well-thought-out mathematics lessons that provide students with a feeling of satisfaction and enjoyment of mathematical activities, while fostering their ability to have good foresight and logical thinking” (p. 12).

Short-term goals come from the unpacking of the long-term ones. As Hart, Alston, and Murata (2011) describe, the goals may be “general at first (e.g. how students understand equivalent fractions), and are increasingly refined and focused [sic] throughout the lesson study process to become specific research questions by the end (e.g. strategies students use to compare 2/4 and 3/6)” (p. 2). Thus, both long-term and short-term goals inform research lesson planning.

Doing the above involves investigating different curriculum materials such as the National Course of Study in the case of Japan, textbooks, course syllabus, and scope and sequence (Ebaeguin & Stephens, 2016; Doig & Groves, 2011), a process referred to as kyozaikenkyu.
Phase 2: Plan

Planning of the research lesson (the lesson to be studied, or researched) in Japan, as observed by many researchers, is considered the centrepiece of the lesson study process (Doig & Groves, 2011; Fernandez & Yoshida, 2004; Lewis, Perry & Hurd, 2004; Takahashi, 2006; Takahashi, Watanabe & Yoshida, 2006). A notable feature is that Japanese research lessons in mathematics are typically designed around solving a single problem to achieve a single objective in a topic (Doig, Groves, & Fujii, 2011; Shimizu, 1999; Takahashi, 2006). These lessons are termed *structured problem-solving lessons* and have a particular format.

The term *hatsumon* is given to the single thought-provoking question, or problem, with which the students engage. According to Doig, Groves and Fujii (2011), “selecting the exact wording of the *hatsumon*, or question posed to the children to solve, is also a critical step in the planning of a lesson” (p. 193). Similarly, Ebaeguin and Stephens (2014a) noted that in crafting the lesson, “even the smallest detail of the lesson are discussed; for example, which numbers to use in the lesson and why these numbers should be used instead of other numbers, and blackboard design” (p. 5).

Another notable feature is that the appropriate selection of the *hatsumon* involves *kyozai-enkyu*, which is the investigation of a large range of instructional materials, including textbooks, curriculum materials, lesson plans, and reports from other lesson studies, as well as a study of students’ prior understandings (Ebaeguin & Stephens, 2014b; Watanabe, Takahashi & Yoshida, 2008, p. 135).

Japanese mathematics research lesson plans contain detailed information (Fujii, 2016; Doig, Groves, & Fujii, 2011; Shimizu, 1999; Takahashi, 2006) with Fujii (2016) stating that in Japan, a lesson plan, *gakushushido-an*, is much larger and broader in scope than what is generally meant by a lesson plan. It is usually five to ten pages long (Groves *et al.* 2016). To construct a lesson plan, Japanese teachers spend a lot of time and energy. A typical Japanese lesson plan template comprises the following:

1. Name of the unit
2. Research theme
3. Current characteristics of students
4. Learning plan for the unit, which includes connections to standards and to prior and subsequent learning, the sequence of lessons in the unit and the tasks for each lesson, and explanation of unit “flow”

5. Plan for the research lesson

6. Background information and data collection forms for observers. (Lewis, 2002a, pp. 127-130)

To help discuss the details of a typical Japanese research lesson plan, extracts from a lesson plan (Kudo, 2015) will be used.

**Name of the unit, unit objectives and research theme**

The name of the unit, unit objectives and research theme are the first components in a lesson plan. An example of these can be seen in Figure 2.2.
Figure 2.2. Excerpt of Japanese Grade 5 Lesson plan showing unit name and goals (Source: Kudo, 2015, p. 1)

The Evaluation Standards address four areas: (i) student interest, eagerness, and attitude; (ii) mathematical way of thinking; (iii) mathematical skills; and (iv) knowledge and understanding.

**Current characteristics of students**

In Figure 2.3, point (2), the teachers have described the students in the specific class for the research lesson in terms of what students already know and the different abilities that teachers want students develop.
Learning plan for the unit

The teachers indicate on the lesson plan what they have learnt about the unit in relation to other units sequenced across grades (see Figure 2.4). Teachers also state the unit plan (see Figure 2.5). The fact that Japanese lesson plans indicate the Unit for the research lesson as well as past and future units, suggests that teachers consider seriously the relationship between the units and become aware of some of the pre-requisite knowledge that students have. Similarly, Figure 2.5 suggests that the current research lesson is informed by past lessons and future lessons in the Unit. In addition, Figure 2.4 suggests that the value of the lessons is stated and that the lesson being planned should align the tasks with the value.
Figure 2.4. Excerpt of Japanese Grade 5 Lesson plan showing the scope and sequence of the topics across grade levels students (Source: Kudo, 2015, p. 3)
A plan for the research lesson
This part of the lesson plan, as can be seen in Figure 2.6, states the lesson goal, what the lesson will emphasise, and the specific strategies to address the research lesson. It is clear from Figure 2.6 that teachers anticipate student responses in detail. Ebaeguin and Stephens (2014a) stated that a detailed examination of the widest range of anticipated student responses allows the Lesson Study group to plan support to students when also incorrect responses caused by student misconceptions come up. For example, Figure 2.7 the last column contains “Support and points of consideration”, stating what the teacher will do to help students during the lesson.
7 About the Lesson

(1) Goal of the lesson

Through the activity of drawing congruent quadrilaterals, students will think about the minimum information needed, and they can explain why.

(2) Emphasis in today’s lesson

In the previous lessons in the unit, these students have learned about the congruence conditions for triangles through manipulation. They have also explored how to draw congruent figures using as few information as possible. In particular, they have learned to draw congruent triangles.

(Some paragraphs left out)

(3) Specific strategies to address the research theme

i. Drawing out questions while engaged in a task (grasp)

In the opening of the lesson, we will review some of the reflections from previous lesson and try to motivate students so that they will think “I can draw congruent quadrilaterals” or “I want to draw congruent quadrilaterals.” We will try to draw out from the students the question, “Can we draw congruent quadrilaterals if we know the lengths of four sides?” just like we could draw congruent triangles when we know the lengths of three sides. We anticipate that many students will respond, “yes,” instinctively. However, once they try to draw congruent quadrilaterals, they soon realize that knowing the lengths of four sides is not enough. By encouraging students to think about why that is the case, we will help them to think about what additional information is needed to draw congruent quadrilaterals.

(2) Through the use of previously learned ideas, making own ideas clear and enjoy the exchange of ideas with friends (Explore)

Figure 2.6. Excerpt of Japanese Grade 5 Lesson plan showing details of the research lesson
(Source: Kudo, 2015, p. 4)

The flow of the lesson shown in Figure 2.7 states the learning content – the main hatsumon and anticipated responses. The last column lists the strategies to address the research theme.
Figure 2.7. Excerpt of Japanese Grade 5 Lesson plan showing the lesson flow (Source: Kudo, 2015, p. 6)

Figure 2.8 shows the summary of the lesson, stating the activities for the lesson conclusion. It is worth noting that students are asked to write a reflection in their books,
Figure 2.8. Excerpt of Japanese Grade 5 Lesson plan showing the summary of the lesson
(Source: Kudo, 2015, p. 9)

The process by which the lesson plan is developed involves considerable collaborative work among teachers, which according to Fujii (2016) is largely under-appreciated by non-Japanese adopters of lesson study, despite recent research into lesson study. Usually, teachers hold more than one planning meeting, mostly with the first meeting having no draft lesson plan. At all other meetings, teachers base their discussions on a draft lesson plan, written, either with or without the support of colleagues, by the teacher who would be teaching the lesson. In addition, the flow of the planning meetings follows the flow of the lesson plan.

In his study of the lesson planning process in three Japanese schools, for example, Fujii (2016) noted that teachers devoted approximately two-thirds of the time to discussing the flow of the research lesson. Within that time, teachers focussed on the appropriateness of the task, anticipated student solutions, and the plan for comparing and discussing these student solutions.

Teachers discuss the task for the research lesson from two perspectives (Fujii, 2016). First, they discuss the task and unit, clarifying the scope and sequence of relevant topics, or relationships within and expansion of the content. Second, they discuss the appropriateness of

<table>
<thead>
<tr>
<th>Summarize/Extend</th>
<th>Verify that to draw a quadrilateral, we need to fix the positions of the four vertices.</th>
<th>By having students write reflections, draw out new questions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T Today, we thought about what information in addition the lengths of sides to draw congruent quadrilaterals. To draw a congruent quadrilateral, we had to find the locations for vertices A and D, didn’t we? We then learned the method to draw a congruent quadrilateral using the measurements of 2 angles in addition to four sides, and also the method to draw using only one angle. We will think about whether or not we can draw a congruent quadrilateral &amp; is we know the length of a diagonal in addition to the lengths of sides. Please write your reflection in your notebooks. Please include whether or not you think we can draw a congruent quadrilateral using a diagonal.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C Can someone read the reflection?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C Today we drew congruent quadrilaterals. At first I thought we could just using the length of 4 sides, but we couldn’t. Then, we learned that we can draw a congruent quadrilateral if we use the measurement of one angle in addition to 4 sides. I want to try to draw a congruent quadrilateral using a diagonal.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C I understood that we can draw congruent quadrilateral using 4 sides and 1 angle. I wonder if we can really draw one using a diagonal.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- - -
the task to the goal of the lesson, including detailed consideration of the “exact wording and numbers to be used” (Stigler & Hiebert, 1999, p. 117). As noted by Fujii (2016), the task might not directly come from textbooks; it can be newly created, or modified from tasks in the textbook. Furthermore, teachers discuss why they selected the particular task; the roles the task would play in the unit; and the benefits students might gain from solving the tasks, such as developing a new concept, a new way of thinking.

Because students are expected to work independently on the task for 10 to 20 minutes, teachers need to discuss the appropriateness of the task described in the lesson plan. The teachers ensure that the task should be understandable by the students with minimal teacher intervention; it should be solvable by at least some students (but not too quickly), and it should lend itself to multiple strategies (Fujii, 2016).

Notably, at planning meetings, teachers frequently refer to the National Course of Study when they need to confirm the role of the unit, or focus lesson, within the entire curriculum.

Phase 3: Conduct research lesson

One member of the group of teachers, who planned the research lesson, teaches the lesson, while the other members of the planning team, other teachers from the school, or relevant subject department, the knowledgeable other (external expert), and all other invited people observe. The invited people may include teachers from other local schools, or teachers and academics from an extended range of schools, with some research lessons being open to teachers nationwide (Lewis, Perry & Hurd, 2005; Doig & Groves, 2011; Lewis, 2004; Takahashi, 2006).

All observers are provided with a copy of the lesson plan and take thorough notes of the lesson, often as well as video and photographic records. The observations focus on student thinking and learning, and observers make detailed notes of students’ solution strategies. Occasionally, observers choose to focus on just one or two students for the entire lesson. Stephens (2011) noted that observations are based on “evidence describing actual teaching, what students did or were not able to do, and about the subject matter or tasks used” (p. 124). Observers do not interact with, nor help, the students or the teacher during the lesson, as the purpose is to observe the implementation of the lesson as planned.
Phase 4: Reflect

After the lesson, the teacher and the observers discuss the research lesson. The discussion focusses on the lesson, particularly how the lesson unfolded in the classroom, and ways to improve the lesson. A school administrator (for example, the principal) chairs the discussion. The teacher who taught the research lesson is accorded the first chance to speak about the lesson and their impressions of what was successful and what was not. Then, other members of the planning team explain the rationale behind the lesson and how the lesson furthers the research theme. Other observers are then invited to comment on the lesson from their detailed notes, and an invited expert, the knowledgeable other, is invited to pull the discussion together and draw out implications relating to the particular lesson and learning and teaching more generally.

Several researchers have indicated the significance of outside expertise provided by the knowledgeable other in making lesson study effective (Takahashi, 2011; Takahashi & Yoshida, 2004). Takahashi (2014) and Fujii (2016) stated that Japanese schools had a custom of inviting a knowledgeable other to their research lesson and asking the person to provide “final comments”. According to Fernandez et al. (2001) a knowledgeable other participates in the lesson study to provide a different perspective on the lesson study work of the group, to provide information about the subject matter content and to share the work of other lesson study groups (p. 18). Similarly, a case study of three experienced knowledgeable others in Japan by Takahashi (2014) revealed several ways in which their final comments helped participants connect the lesson with broad issues in mathematics and pedagogy.

These post-lesson discussions often last up to two hours, and are (at the local level anyway) often followed by a meal at a local restaurant where discussion often continues (Doig & Groves, 2011; Fernandez & Yoshida, 2004; Lewis, 2002a; Takahashi, 2006).

Concerning activities following the post-lesson discussion, the literature indicates that in Japan it is optional to re-teach the revised research lesson. Fernandez and Yoshida (2004), for example, stated that some groups would stop their work on a research lesson after they have discussed their observations, but others will choose to go on to revise and re-teach the lesson so that they can continue to learn from it. If they decide to re-teach a revised lesson, a second member of the group will teach the lesson to a different class. The teacher and students are varied to provide the group with a broader base of expertise to learn from, and to give as many
teachers as possible chance to teach in front of others (Fernandez & Yoshida, 2004).

However, Fujii (2014) believes that having a requirement to re-teach the lesson is a misconception. He believes the roots of this misunderstanding may stem from the steps in lesson study described in *The Teaching Gap* (Stigler & Hiebert, 1999, pp. 112–113). Among these is Step 6: *Teaching the revised lesson*. According to Fujii (2014), this “suggests a practice of revising a faulty part and replacing it in the revised lesson” (p. 11). He reasons that unlike inorganic systems, such as a car, where a faulty part may be easily replaced, lesson study is organic with systemic parts. Furthermore, Fujii (2014) states that reteaching re-enforces the idea that the same lesson plan can be used with different students. This idea disregards the importance of students. This, according to Fujii, “is in outright opposition to a core value of lesson study” that students are the focus of lesson study. According to Fujii, re-teaching is also disrespectful of students’ right to the best education one can provide:

> Having the thought of re-teaching at the back of one’s mind is like making the first class a pawn in order to improve classroom teaching. This benefits teachers and lesson plan makers at the expense of students. (Fujii, 2014, p. 12)

More recently, in an attempt to identify the essential features of lesson study, Takahashi and McDougal (2016) stated that the following features are likely to be important for effective lesson study:

1. Participants engage in lesson study to build expertise and learn something new, not to refine a lesson.
2. It is part of a highly structured, school-wide or sometimes district-wide process.
3. It includes significant time spent on *kyouzai kenkyuu*.
4. It is done over several weeks rather than a few hours.
5. Knowledgeable others contribute insights during the post-lesson discussion and during planning as well. (pp. 515–516)

### 2.3.1 Implications for this research

The literature on Japanese Lesson Study has explicated critical features that other countries adopting lesson study should consider. Therefore, it is important to investigate which
features of lesson study are emphasised in lesson study in Zambia, in terms of both policy and practice.

2.4 The Japanese structured problem-solving approach

Problem solving in mathematics has had a great deal of scholarly attention over the last few decades. Schoenfeld (1992) stated that problem-solving is a process in which students are asked to find a solution to a mathematical problem for which they know no immediate solution, and no algorithm that they can directly use to find one. Students are at the centre of the process and are responsible for reading the mathematical problem carefully, analysing the information in the question, and examining their own mathematical knowledge to discover a strategy to find a solution.

Many scholars and educators have argued that teaching through problem-solving approach benefits students more than teaching through other approaches. Empirical research has confirmed this claim (see, for example, Ali, Akhter & Khan 2010; Gallagher, Stepien, Sher & Workman, 1995; Major, Baden & Mackinnon; 2000; Okereke, 2006).

Okereke (2006) for example, argued that mathematics should be taught using problem solving because the approach is centred on the students, and is capable of promoting active and motivated learning as well as the acquisition of problem-solving skills. This argument resonates with the statement by Major et al. (2000) that students take much more responsibility for their learning in classrooms that use problem-solving instructional processes. In addition, Gallagher et al. (1995) stated that a problem-solving approach made students act as professional mathematicians, and enabled them to tackle challenging problems.

Although the literature proposes that problem solving should be a fundamental goal of teaching mathematics, Stacey (2005) stated that, although it is “one of the most fundamental goals of teaching mathematics, [it is] … also one of the most elusive” (p. 341). However, many researchers (for example, Isoda, 2010; Shimizu, 1999; Stigler & Hiebert, 1999; Takahashi, 2008; Takahashi, Lewis & Perry, 2013) have noted that the typical mathematics lesson in Japan is taught using this approach, with Stigler and Hiebert (1999) summarising several features of Japanese mathematics lessons and labelling these lessons as “structured problem-solving”: 
In Japan, teachers appear to take a less active role, allowing their students to invent their own procedures for solving problems. And those problems are quite demanding, both procedurally and conceptually. Teacher, however, carefully design and orchestrate lessons so that students are likely to use procedures that have been developed recently in class. An appropriate motto for Japanese teaching would be “structured problem-solving”. (Stigler & Hiebert, 1999, p. 27)

Takahashi (2000) stated that Japanese structured problem-solving lessons were designed to create interest in mathematics and stimulate creative mathematical activity in the classroom through students’ collaborative work. The focus was to enable students to develop mathematical concepts, skills, and procedures (Takahashi, 2006). Similarly, Lewis (2011) stated that the goal of Japanese structured problem-solving lessons was to build students’ mathematical knowledge, their mathematical practices, and habits of mind – such as sense-making, perseverance, constructing and critiquing arguments, modelling with mathematics, keeping track of data.

In contrast, some scholars (for example, Lesh & Zawojewski, 2007; Takahashi, 2006) have argued that problem-solving lessons outside Japan, such as those taught in the USA, focus on developing problem-solving skills and strategies by showing students how to solve a problem and asking students to practise the solution method. Lesh and Zawojewski (2007) stated that problem-solving lessons outside Japan could take various forms, such as practising of previously taught content using word problems, a universal set of steps, a collection of heuristics, or the mobilisation of mathematical knowledge, strategies, dispositions, and beliefs, to investigate unique problems.

According to Shimizu (1999), a typical mathematics lesson in Japan, comprises four steps: (1) Presentation of a problem, (2) Individual problem-solving by students, (3) Whole-class discussion about the methods for solving the problem, and (4) Summing up by the teacher. Shimizu (1999) defines and names the four pedagogical terms commonly used in relation to these four steps of the lesson: Hatsumon, Kikan-shido, Neriage, and Matome.

Step 1: Hatsumon refers to “the [single] key question that provokes students’ thinking at a particular point in the lesson” (Shimizu, 1999, p. 110). At the beginning of the lesson, the teacher might pose a question to investigate or encourage students’ understanding of the problem. Doig, Groves and Fujii (2011) emphasise the care with which this single problem or
task is selected for the problem-solving activity. They state that a task is chosen through kyozaikenkyu – an intensive and complex investigation of a range of instructional materials. Fujii (2014) states that Japanese educators teach mathematics through solving the task, and if chosen well, “a single task allows for the important new mathematical ideas to emerge in the discussion, and additional tasks are unnecessary” (p. 5).

Step 2: Kikan-shido refers to “instruction at students’ desk and includes a purposeful scanning by the teacher of the students’ individual problem-solving processes” (Shimizu, 1999, p. 110) or as Becker, Silver, Kantowski, Travers and Wilson (1990) put it, “purposeful scanning” (p. 15). Kikan-shido includes the teacher performing two critical activities that are firmly attached to the entire class discourse that will take place after the individual work. To start with, the teacher evaluates students’ problem-solving progress. Second, the teacher carefully considers which students utilized the expected approaches (outlined in the lesson plan) and which students used different approaches to the problem (Shimizu, 1999).

Step 3: Neriage in Japanese means kneading or polishing up. According to Shimizu (1999), neriage is “a metaphor for the process of polishing students’ ideas and of developing an integrated mathematical idea through the whole-class discussion. Japanese teachers regard neriage as critical for the success or failure of the lesson” (p. 110). According to Takahashi (2006), neriage denotes the teacher “facilitate[ing] mathematical discussion after each student comes up with a solution” (p. 42).

Step 4: Matome in Japanese means summing up. Japanese teachers think that this stage is indispensable for a successful lesson. In this stage, the teacher reviews what students have discussed in the whole-class discussion and summarizes what they have learned during the lesson (Shimizu, 1999). According to Fujii, Kumagi, Shimizu, and Sugiyama (as cited in Fujii, 2016), the teacher could just say which strategy is the most fruitful or correct, and why; however, matome ought to transcend that to incorporate comments by the teacher regarding the mathematical and academic value of the task and lesson. Fujii (2016) stated that while the matome should be indicated in the lesson plan, for a lesson to incorporate successful matome the “task should be understandable by the students with minimal teacher intervention; it should be solvable by at least some students (but not too quickly), and it should lend itself to multiple strategies” (Fujii, 2016, p. 414).

Further, Fujii, Kumagi, Shimizu, and Sugiyama (as cited by Shimizu, 1999) stated that
most teachers in the USA did not include *matome* at the end of a lesson, a situation that, according to Fujii (2015), leaves the students feeling unsatisfied with what was presented to them.

### 2.4.1 Implications for this research

This section has described Japanese structured problem-solving lessons that are typically used in mathematics research lesson in Japanese Lesson Study. This study will investigate the extent to which research lessons in mathematics in Zambia are both expected to follow the structured problem-solving approach and do so in practice in order to gauge the adaptations of Japanese Lesson Study in Zambia.

### 2.5 Adoption and adaptation of lesson study outside Japan

Previous research on lesson study implemented outside Japan has highlighted some of the challenges countries face in adopting or adapting Japanese Lesson Study. Analysing and presenting literature on every country is beyond the scope of this thesis; for that reason, this review is restricted to Australia, the United States of America (USA), England, and some African nations.

#### 2.5.1 The United States of America

Japanese Lesson Study was first introduced to the United States of America (USA) in 1999, through Yoshida’s (1999) doctoral dissertation, *Lesson study: A case study of a Japanese approach to improving instruction through school-based teacher development*, and Stigler and Hiebert’s (1999) book *The teaching gap: Best ideas from the world’s teachers for improving education in the classroom*. The latter summarised the *Third International Mathematics and Science Study* (TIMSS) video study of 8th grade mathematics teachers in the USA, Germany, and Japan. Stigler and Hiebert (1999) challenged USA educators to try lesson study as a way to build professional knowledge of teaching and improve teaching and learning:

> Our goal is simply to convince the reader that something like lesson study deserves to be tested seriously in the United States. It is our hypothesis that if our educational
system can find a way to use lesson study for building professional knowledge of teaching, teaching and learning will improve. (Stigler & Hiebert, 1999, p. 131)

After the *Teaching Gap* ignited interest in lesson study among USA teachers, researchers, and educational policymakers, there have been numerous adaptations of lesson study in the USA.

Several teacher-initiated lesson study groups have implemented lesson study in the USA. By 2004, adaptations of lesson study were taking place in over 335 schools across 32 states (Lewis, Perry & Murata, 2006), with researchers such as Lewis, Perry, Hurd, and O’Connell (2006), and Perry and Lewis (2009) noting the durability, success, and spread of some teacher-initiated lesson study efforts across the country.

In their article *Lesson study comes of age in North America*, Lewis *et al.* (2006) stated that lesson study had spread rapidly in the USA since 1999, and discussed in detail the growth and success of lesson study at Highlands Elementary School in California’s San Mateo-Foster City School District, and identified conditions needed for scaling up this example. According to Lewis *et al.* (2006), the development of lesson study at Highlands Elementary School, which served just over 400 grade K to 5 students, provided both, an existence proof that USA teachers could use lesson study to improve instruction, and a window into the conditions needed for its success.

Lewis *et al.* (2006) stated that after 26 volunteers at Highlands Elementary School conducted two lesson study cycles during the 2000-01 school year and presented the results to the Highlands faculty in the Spring of 2001, nearly “all of the Highlands faculty decided to begin lesson study the following fall [Autumn], and the remaining faculty joined the next year” (p. 274). Since then, lesson study had continued at Highlands, with lesson study groups typically comprising three to six teachers from the same or adjacent grade levels, conducting two cycles of lesson study per year and sharing what they learnt with the entire staff at regular intervals.

At Highlands Elementary School, lesson study seemed to have had particular power because lesson study was supported by a school-wide vision, and all the teachers in the school participated:
The faculty selects a school-wide research theme (for example, reduction of the achievement gap) that provides a common focus for the work of the lesson study groups. (Lewis et al., 2006, p. 273)

Over the course of the study, Highlands’s teachers had extended their focus from the surface features of lesson study (for example, development of lesson plans) to its underlying principles (for example, increasing teachers’ opportunities to learn from one another, from practice, and from the curriculum). In particular, four beliefs about lesson study at Highlands were developed:

1. Lesson study is about teacher learning, not just about lessons.
2. Effective lesson study hinges on skilful observation and subsequent discussion.
3. Lesson study is enhanced by turning to outside sources of knowledge.
4. The phases of the lesson study cycle are balanced and integrated. (Lewis et al., 2006, pp. 274-275)

Lewis et al. (2006) addressed the question of what other lesson study sites could learn from Highlands, stating three aspects of the lesson study effort there that seemed to distinguish it from sites where lesson study had not taken hold. The first distinctive aspect was referred to as the *learning stance*, where teachers figured out how to make lesson study work in the USA instead of reproducing lesson study from the Japanese blueprint. To do so, teachers drew actively on the knowledge and experience of lesson study researchers and practitioners, … They built internal and external formative assessment into their work, regularly using it to modify both their lesson study process and their knowledge of mathematics teaching and learning. (Lewis et al., 2006, p. 277)

The second distinctive aspect was referred to as *internal ownership — external knowledge access*. Lewis et al. (2006) stated that Highlands teachers managed to draw actively on external knowledge even as they maintained internal ownership of the lesson study effort. They benefitted from the assistance of local university-based educators, a long-term foundation-funded mathematics initiative, and Japanese colleagues willing to visit the district to engage in joint lesson study one or more times each year.

The third distinctive aspect was referred to as *serving the school’s work*. Highlands used lesson study to respond to external mandates. Lewis et al. (2006) stated that the school
principal’s vision of lesson study as a vehicle to accomplish important school-wide work led her to support it in distinctive ways that are not found at schools where lesson study is simply one choice from a pot-pourri of professional development options. The school principal provides such resources as books and student data that help teachers focus on particular challenges facing the school; she creates meeting agendas that help lesson study teams connect their work to the school-wide research theme ... and she regularly assesses the progress of the lesson study by participating in a group, reading notes from the various groups, and providing opportunities for school-wide sharing of the lesson study work and results. (Lewis et al., 2006, p. 278)

Addressing what it would take to scale up the Highlands’ lesson study, Lewis et al. (2006) stated that the work at Highlands provided evidence that USA teachers could overcome the obstacles initially anticipated for lesson study, namely lack of time, minimal collaborative experience, and limited access to content knowledge. Lewis et al. (2006) proposed four changes in the larger education policy climate that could help practice-based learning systems like that at Highlands to become widespread: cross-site learning about lesson study, a diverse ecology of lesson study, pathways linking lesson study to textbooks, and provision for inside-out reform.

Among a number of lesson study groups that have been established in the USA are the Lesson Study Group at Mills College, which has been conducting research on this approach in USA settings, including schools, districts and pre-service education since 1999, and the Chicago Lesson Study Group (CLSG), which has been conducting conferences and public research lessons since 2006. Japanese educators and scholars such as Takahashi, now resident in the USA, have been instrumental in helping schools in the USA implement lesson study, with significant collaboration taking place between these two lesson study groups.


Supported by a federal government grant, the Teaching Through Problem-Solving (TTP) project focussed on an adaptation of lesson study to USA settings, the nature of teachers’ learning during lesson study, and the ways in which outside experts and resources – especially those from Japan – could support teachers’ learning. It tried an innovative method (lesson study,
using Japanese TTP materials) to support the implementation of the Common Core State Standards (CCSS). The materials used were produced partly through the *Focused [sic] and Coherent Elementary Mathematics: Adapting a Japanese K-2 Curriculum for Use in the United States* project, which was designed to translate and adapt the *Tokyo Shoseki’s Mathematics* textbook series, the series most widely used in Japanese elementary schools. The three-year TTP project supported collaboration with a network of USA elementary teachers in selected sites across the USA.

Reporting on the early phase of the TTP project, Takahashi, Lewis, and Perry (2013) stated that this design showed promise for allowing lesson study to flow into US teacher practice.

### 2.5.2 Australia

The history of lesson study in Australia dates back to 2001 when the New South Wales Department of Education and Training, in conjunction with the Australian Quality Teaching Programme, initiated a trial project called *lesson study*. The lesson study Trial Phase was conducted in Semester 2 of 2001, using a sample of three secondary schools, involving twelve teachers. Based on the outcomes of the Trial Phase, Phase One started in March 2002 and ended in June 2002. It involved 36 schools and over 100 teachers. Phase Two began in August 2002 and ended in November 2002. It involved 45 government secondary schools (White & Southwell, 2003).

In March 2002, the Mathematics Education Research Team at the University of Western Sydney began the evaluation of the project. The evaluation concluded that the lesson study programme succeeded on all five levels of Guskey’s (2002, p. 82) framework for evaluating professional development programmes.

The evaluation reported a number of benefits from the project. For example, teachers reported developing a lesson study mentality that allowed them to apply the skills and knowledge they had acquired to their daily teaching. Furthermore, a meaningful context was provided for non-threatening lesson observation and the development of greater collaboration and sharing among the team and with the wider mathematics staff. Notably, lessons developed were enthusiastically received by students and resulted in higher learning outcomes and an
improvement in student motivation, engagement, and attitude towards mathematics (White & Southwell, 2003).

While there were benefits arising from the lesson study project, there were also some process challenges, including

[F]inding suitable meeting times; getting other staff to be involved and enthusiastic about the project; fears of staff being reluctant to try new strategies and to be reluctant to share; finding suitable mathematics casual replacements; and teachers seeing the project as another imposition on their already crowded day. (White & Southwell, 2003, p. 2)

According to Lim, White, and Chiew (2005), in an article comparing the implementation of lesson study in Australia and Malaysia, lesson study in New South Wales grew from three suburban secondary schools in 2001 to over two hundred secondary schools from across the state by the end of 2004, when funding for the continuation of the project was discontinued.

Since 2001, there have been attempts to introduce lesson study outside NSW. At state level the, State of Victoria Department of Education and Early Childhood and Development (DEECD), for example, committed itself to providing school environments suitable for lesson study adaptation. In addition, the Parliament of Victoria Education and Training Committee’s (2009) Inquiry into effective strategies for teacher professional learning: Final report supported lesson study as “consistent with current trends towards school-based professional development, and reflective, collaborative learning in Victoria schools” (p. 69).

Several lesson study adaptations in Victoria have been reported in the literature. For example, Hollingsworth and Oliver (2005) reported on a small-scale study at Ballarat and Clarendon College in Victoria starting in 2004. Two groups of teachers engaged in lesson study, with one focussing on mathematics and the other on literacy. The teachers in the mathematics group met fortnightly trying to develop a single exemplary lesson, questioning and debating mathematics and its teaching and learning. Hollingsworth and Oliver (2005) found that teachers participating in the lesson study group benefitted by engaging in these rich discussions: for example, teacher’s professional reading increased and this, in turn, improved the teachers’ knowledge with respect to current best practice. At a staff level, expertise was shared between
staff, and the respect and acknowledgement of each other’s skills and ability increased. At a school level, lesson study demonstrated to all staff that there was strong expertise along with great learning taking place in the mathematics department.

According to Hollingsworth and Oliver (2005), crucial factors in the success of the lesson study project were the “time afforded to the process … [and the] commitment demonstrated by …peer-participant-colleagues, administrators and the consultant” (p. 7). In addition, there was an open expectation that the college was a centre for teacher learning for the improvement of teaching, with the facilities and structure of the College assisting teacher development and reflection. Future directions included expanding the mathematics lesson study project to further research lessons and new groups of mathematics teachers.

Another lesson study project was undertaken as part of the action research project Improving numeracy teaching through data analysis in a cluster of one secondary and five primary schools in the outer south-eastern suburbs of Melbourne. This project, which was concerned with using school data to analyse weaknesses and then improve existing teaching programmes, determined the initial focus on fractions. According to Sanders (2009), the project involved a Cluster Numeracy Team who, over a period of eighteen months, developed and implemented fractions tasks in cluster classrooms using lesson study as a professional learning model. Implementation began with a professional learning day for teachers from each of the cluster schools. Research lessons were revised and re-taught, with lesson study sessions including a reflection session that was written up as part of the lesson study protocol. Part of this evaluation was a discussion of possible lesson revisions and which of the teachers would trial these revisions with their class. Feedback from these trials was incorporated into the lesson plan for future use. According to Sanders (2009), this “highlights a weakness in this project’s development of Lesson Study. The process should involve the same group in revising and re-teaching the lesson with a final reflection session” (p. 478). Sanders (2009) concluded that developing lesson study “within cluster schools could clearly benefit individual schools and is an issue which warrants further consideration” (p. 482).

Groves, Doig, Vale, and Widjaja (2016) reported on a research project, Implementing structured problem-solving mathematics lessons through lesson study, carried out in three Victorian schools during 2012, and continued in a modified form during 2013 and 2014. The research team worked with a team of two Year 3 and 4 teachers from each of the three
participating schools during 2012 to explore ways in which essentials of Japanese Lesson Study could be implanted into Australian mathematics teaching and professional learning. The three schools were part of a network of 27 government schools located in a single school region. The research team and a key leading teacher at each school supported the teachers.

According to Groves et al. (2016), “In many non-Japanese adaptations of [lesson study], decisions are made a priori to dispense with certain features … [but] by way of contrast, every attempt was made in our project to implement JLS as ‘authentically as possible’” (pp. 503–4). Participating teachers took part in an initial whole-day professional learning session on Japanese Lesson Study in July, and participated in one lesson study cycle during each of Terms 3 and 4 of 2012. Each lesson study cycle involved two cross-school teams of three teachers and two numeracy coaches planning a research lesson, based on their team’s adaptation of the same problem, during four two-hour planning sessions, with one member of each team teaching the lesson to their own class in front of observers. Observers included project participants, key staff at each school, all interested teachers who could be released from their classes, as well as other professionals such as teachers and mathematics educators, and a knowledgeable other.

Two major aims of the project were to investigate critical factors in the adaptation and effective implementation of structured problem-solving mathematics lessons, and Japanese Lesson Study as a model for teacher professional learning in the Australian context. According to Widjaja, Vale, Groves and Doig (2017, p. 379), “investing in in-depth, quality planning, with a focus on advancing students’ thinking and building teachers’ capacity for implementing structured problem-solving lessons through lesson study, leads to teachers’ professional growth”. According to Groves et al. (2016), the critical factors, identified by the teachers, as contributing to the success of the project included:

The opportunities for in-depth lesson planning, the presence of large numbers of observers at the research lessons and the post-lesson discussions, and the insight provided by the “knowledgeable other”. (p. 501)

They also reported major constraints as including the difficulty in finding suitable problem-solving tasks to match the Australian curriculum, and the teaching culture that emphasises small group rather than whole-class teaching.

In earlier work, Groves and Doig (2010) stated that the teaching culture in Australia
views teaching as a private activity. This culture can inhibit an adoption of Japanese Lesson Study, which views teaching as a public activity. In Japan, the focus is on the classroom as a community of learners, while the Australian focus is more on individual differences. This can inhibit the sense of community of teachers to engage in the structured problem-solving lessons that form the basis for lesson study in mathematics. In Japan, although the preparation for lesson study takes place outside school hours, the established tradition of lesson study permits suitable arrangements to be made for conducting the observed lessons and the post-lesson debriefing discussions. In Australia, “a major constraint to such activity is the fact that most schools would need to employ casual teachers to take the place of teachers observing lessons in other classes or schools” (Groves & Doig, 2010, p. 89).

2.5.3 England

According to Dudley (2011), lesson study was introduced in England in 2001, when Britain’s Teaching and Learning Research Programme (TLRP) funded a project, Learning how to learn across classrooms, schools and networks, aimed at investigating how classroom practices that harnessed a pedagogical approach based upon formative assessment could be transferred effectively from teacher-to-teacher, school-to-school, and network-to-network. Classroom application of formative assessment was guided by six principles developed by Black and William (1998), with the Assessment Reform Group (1999) coining the term assessment for learning (AfL) to describe the operation of these principles. The project started working with 45 primary and secondary schools to investigate ways in which AfL practices could be developed, captured, and transferred between teachers and across schools (Dudley, 2011).

As a TLRP research fellow linked with this project, Dudley began to investigate how lesson study might support teacher development and enable the transfer of AfL pedagogical approaches. Initially, Dudley’s lesson study project aimed to find out whether lesson study would work in England. At the same time, Dudley was required to conduct a literature review investigating, among other topics, lesson study, and teacher learning that most effectively influenced classroom learning (Dudley, 2011). An initial pilot study, funded by the Economic and Social Research Council and the TLRP, conducted over 100 research lessons across Key Stages 1–4 (although mainly in Key Stage 3), in a range of schools representing a cross-section
of educational contexts. Teachers and senior school managers, recruited from 14 schools (11 secondary and three primary), attended a two-day residential session, which provided a theoretical and practical introduction to lesson study. The group met each term in two-day residential sessions to review and share lesson studies that they had undertaken in their schools. Dudley also set up the Lesson Study UK website, www.lessonstudy.co.uk.

Dudley (2014, p. 5) stated that a “Lesson Study consists of a cycle of at least three ‘research lessons’ that are jointly planned, taught/observed and analysed by a Lesson Study group”. As can be seen from Figure 2.9, each cycle comprised four stages: joint planning of research lesson; teaching and observing the lesson; interviewing case pupils; and holding post-lesson discussions.

![Figure 2.9. The Lesson Study process (Source: Dudley 2014, p. 5)](image)

Teachers reviewed relevant teaching materials – including previous lesson studies – identified what resources would be used and how, and what the teacher would write on the board, in a process that Dudley (2014) referred to as kyozaikenkyu. Among the features of the pilot project were the use of case-study students who would be the focus for observation during the research lessons. Typically, there might be three such students, perhaps chosen to represent
higher, middle or lower attainment. The lesson study team held a post research lesson discussion within 24 hours after the research lesson. According to Dudley, the final commentator, or Knowledgeable other, as they are known in Japan, played an important role in facilitating lesson studies and cross-fertilizing ideas and developments from school to school. He posited that subject leaders could play a similar role – “especially if they have participated in a Lesson Study cycle themselves and become a champion in school” (p.7). Similarly, Wake et al. (2013) state that an important member of the lesson study group was the knowledgeable other, a mathematics education expert who aimed to make a particularly significant contribution to the post-lesson discussion by providing insights informed by research and in-depth curriculum knowledge.

The outcomes of this pilot project demonstrated that the lesson study approach had a positive effect on student learning. In addition, key factors influencing teacher learning were identified. These included the promotion of joint risk-taking by lesson study group members, following a structured, deliberative process, and the contextualizing of teacher learning in classrooms. The effectiveness of lesson study was also found to be related to school leadership improvement (Dudley, 2011).

A small, five-month-long study by Ylonen and Norwich (2012) explored lesson study’s usefulness as a vehicle for professional development in two departments in a secondary school in England. The study found that teachers encountered some logistical challenges to the implementation of lesson study, and a number of significant gains.

In an article questioning the extent to which lesson study fits with England’s current performative culture of education, Williams, Ryan and Morgan (2014) discussed a number of other small-scale lesson study projects and the adaptations made. They identified the crucial role played by the support of senior management in “providing the ‘space’ for lesson study practice to evolve, and in allowing risk-taking and investment in time to support long-term change in practice that was owned and directed by the teachers” (p. 165).

An investigation of lesson study at the University of Nottingham conducted a lesson study pilot survey during term 1 of 2012. The survey investigated the potential of Japanese Lesson Study to support the professional learning of mathematics teachers, and was carried out in collaboration with the International Math-teacher Professionalization Using Lesson Study (IMPULS) group at Tokyo Gakugei University. The outcome of this was a project involving
two clusters of schools, one of four schools in the Midlands, and another of five schools in London, working in collaboration with the University of Nottingham and King’s College, London. Over the course of the project, about 30 research lessons based on the Bowland mathematics materials were taught, observed, and discussed.

Based on this, the LeMaPS: Lessons for Mathematical Problem Solving project was implemented during 2014-2015 to address two questions:

- How can models of professional learning for secondary school teachers, based on lesson study, be developed and sustained within current and changing systems and structures of school governance and funding mechanisms?
- What supporting tools would help collaborative partnerships to implement lesson study for mathematical problem-solving in effective ways that are both sustainable and scalable?

This project took its own, particular, view of lesson study, one that is a core feature of its implementation in Japan: that lesson study should be embedded in a culture of teacher research and should have the support of mathematics education experts, typically found in universities. This English lesson study model expanded and enhanced existing models that were based on teachers’ peer observation and reflection.

In England, the National Curriculum for Mathematics of 2007 (Qualifications and Curriculum Authority, QCA, 2007) listed the following essential skills and processes in mathematics that students need to learn to make progress: representing, analysing, interpreting and evaluating, and communicating and reflecting (pp. 158-160). These key processes were organised using a problem-solving cycle.

However, Wake, Swan, and Foster (2015) reported that their early research revealed that teachers found it very hard to focus on these mathematical problem-solving processes in lessons. Further, Foster, Wake, and Swan (2014) noted that national and school-based constraints meant that day-to-day classroom practice was almost entirely concept-orientated. The limitations in teachers’ understanding of the key processes were potentially harmful to students’ learning (Wake et al., 2015).

In this vein, Wake et al. (2015) noted that a particular challenge was to ensure that external, research-informed expertise supported lesson study groups in England. One such
support described by Wake, Foster, and Swan (2013) was the use of *Cultural Historical Activity Theory* (CHAT), conceptualised in Figure 2.10, as a powerful theoretical lens through which to view the introduction of lesson study across cultural boundaries.

![Figure 2.10. Interacting activity systems of classroom and lesson study group (Source: Wake *et al.*, 2013, p. 371).](image)

Figure 2.10 shows how a range of different influences mediates the activity of a community viewed as an activity system. In the upper triangles in Figure 2.10, the lesson plan, discourse, and other tools mediate the action of an individual (subject) in pursuit of a goal-directed outcome (object). In the lower triangles of Figure 2.10, the division of labour, and rules and norms mediate the action of collective individuals (for example, a lesson study group) in pursuit of a goal-directed outcome (object).

Wake *et al*. (2013) considered the interaction of the activity systems of classroom (student learning of mathematics) and lesson study group (professional learning), and concluded that the lesson plan was at the nexus of understanding teaching and learning intentions:

> In the classroom it [the lesson plan] acts as a mediating instrument, as a script by which the teacher organises the research lesson, but it has other roles to play beyond this at different times in the activity of the lesson study group. For example, in initial planning the lesson plan provides documentation of, and encapsulates, their values, understandings, beliefs and intentions, whereas in the post-lesson discussion it again acts as a mediating instrument, this time facilitating discussion of these and their enactment as pedagogical practices in the classroom. (Wake *et al.*, 2013, p. 372)
Further, Wake et al. (2013) argued that teachers’ professional learning takes place at the boundary and is centred on the lesson plan that, as a boundary object, embodies the group’s shared and emerging perspectives on practice. Boundary object, a term coined by Star and Griesemer (1989), is defined as follows:

Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. (Star & Griesemer, 1989, p. 393)

In this context, Wake et al. (2013) claim that seeing the lesson plan as a boundary object can help understand how the various actors (teachers, students, knowledgeable others, school administrators, and others) can co-operate and achieve their objectives, despite having different and often conflicting interests:

The theoretical ideas we have set out above provide a valuable lens, which we have used to reflect on our work on professional learning using lesson study with networks of schools in England. In addition to our role as researchers, we also act as “knowledgeable others” and our use of CHAT has provided us with some useful tools, including discourse, with which to consider the conflicts and contradictions that we have not only observed but also experienced. (Wake et al., 2013, p. 374)

In this way, Wake et al. (2013) advocated that CHAT would be of use to lesson study groups by facilitating better conceptualisation and understanding of their professional learning. Using CHAT could “facilitate the development of a common understanding of goals and outcomes of the [lesson study] group, and discourse with which they can articulate and discuss these” (Wake et al., 2013, p. 373). Their model of the structured problem-solving was the English National Curriculum in Mathematics implemented in schools. As already stated the Curriculum advocated the teaching of mathematics using a problem-solving cycle comprising: representing, analysing, interpreting and evaluating, with over-arching competencies identified as communicating and reflecting.

Regarding the extent that lesson study in mathematics in England used a structured problem-solving approach, Wake et al. (2013) stated, “Our lesson study … focuses on research lessons in which students develop mathematical problem-solving skills rather than build specific mathematical content knowledge” (p. 370). This statement was made with reference to
the English National Curriculum in Mathematics, which advocated the teaching of mathematics using a problem-solving cycle, which comprises “representing”, “analysing”, “interpreting” and “evaluating”, with over-arching competencies identified as “communicating” and “reflecting” (Wake et al., 2013, p. 370).

2.5.4 African countries

The adoption of lesson study in various countries in Africa dates back to the late 2000s, with the Japan International Co-operation Agency (JICA) helping many countries to develop projects for strengthening mathematics and science education. Established in 1974, JICA aims to contribute to the promotion of international co-operation as well as the sound development of Japanese and global economy by supporting the socio-economic development, recovery, or economic stability of developing nations. In Africa, JICA has been supporting science and mathematics education since 1998. JICA (n.d.) stated that in Africa, although developing human resources with scientific knowledge and skills necessary for industrial development was urgent, children had poor skills in science and mathematics, attributing the cause to the lack of teachers’ leadership skills. Furthermore, JICA stated that training that supplemented the lack of teachers’ subject knowledge and ability to practise teaching was not well developed.

To deal with these problems, JICA has been developing science and mathematics education projects for strengthening teacher training in some African countries. The first was a 10-year project in Kenya, Secondary Education Plan, beginning in 1998. The project trained about 20 000 secondary mathematics and science teachers in lesson study throughout Kenya (JICA, 2014). JICA claimed that because of the training, mathematics and science lessons have changed dramatically, students’ thinking has improved, and students’ interest in mathematics and science has increased. Due to this, JICA extended its support to other African countries interested in developing mathematics and science education projects for strengthening teacher professional development.

Countries in Africa that JICA has supported to implement lesson study include Ghana (Acquah, Adzifome & Afful-Broni, 2013), Malawi (Fujii, 2014), South Africa (Ono & Ferreira, 2010); Uganda (Ishihara, 2012), and Zambia (Baba & Nakai, 2011). According to Ishihara (2012), JICA initial training and financial resources motivated some African countries to implement lesson study. Furthermore, some African countries co-operated and adopted lesson
study from other nations. For example, during the Regional Conference held in Zambia in 2007, Zambia’s lesson study approach and activities attracted participant interest from each country. This led to some countries attempting to adopt the lesson study approach and activities in their countries. Uganda, for example, became interested in Zambia’s school-based teacher professional development and the experiences gained through lesson study (Ishihara, 2012).

Several studies have claimed that lesson study is improving teacher professional development in Africa. For example, Acquah et al. (2013) used a descriptive survey to investigate the benefits that 46 basic (Years 1-9) school teachers in the Akuapem North District in Ghana claimed to have derived from the lesson study model. Teachers reported that their competencies had improved in knowledge of subject matter, lesson planning, lesson preparation, and teaching material development and usage. Some of the recommendations were that co-operation in education between Ghana and Japan should be sustained so that more teachers could be trained and learn from the Japanese expertise, so that they could implement effectively the lesson study model. Furthermore, the study recommended that a more lasting and realistic effect of lesson study should be ensured by training school heads, directors of education of the Ghana Education Service, and policymakers in education.

In South Africa, a framework, Mathematics Discourse in Instruction (MDI) was developed to enhance lesson planning and reflection. Adler and Ronda (2016) stated that the Wits Maths Connect Secondary Project (WMCS) had been working with secondary mathematics teachers in several districts in one province in South Africa. The project used an adapted version of lesson study where teams of teachers and project researchers planned, taught, reflected on, re-planned, and re-taught a research lesson, and used the MDI framework to structure planning and reflection in the lesson study. Figure 2.11 shows the MDI lesson template, while Figure 2.12 shows a sample research lesson plan on the topic of Functions (Hyperbola graph) for Grade 10.
Lesson goal: What do we want learners to know and be able to do?

<table>
<thead>
<tr>
<th>Exemplification</th>
<th>Explanatory communication</th>
<th>Learner Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples, tasks and</td>
<td>Word use and justifications</td>
<td>Doing maths and talking maths</td>
</tr>
<tr>
<td>representations</td>
<td>What is said?</td>
<td></td>
</tr>
<tr>
<td>What examples are used?</td>
<td>What is written?</td>
<td>What do learners say?</td>
</tr>
<tr>
<td>What are the associated</td>
<td>How is it justified?</td>
<td>What do learners write?</td>
</tr>
<tr>
<td>tasks?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What representations are</td>
<td></td>
<td>Does learner activity build</td>
</tr>
<tr>
<td>used?</td>
<td></td>
<td>towards the lesson goal?</td>
</tr>
<tr>
<td>Building generality</td>
<td>Informal – formal</td>
<td></td>
</tr>
<tr>
<td>Structure</td>
<td>Mathematical substantiations</td>
<td></td>
</tr>
<tr>
<td>Variation amidst</td>
<td>Principles</td>
<td></td>
</tr>
<tr>
<td>invariance</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Coherence and connections: Are there coherent connections between
- the lesson goal, examples, tasks, explanations and learner participation?
- from one part of the lesson to the next

Figure 2.11. The WMCS mathematics teaching framework (Source: Adler, 2017, p. 139)
As shown in Figure 2.12, the research lesson involved giving a series of examples on how to tackle the tasks. Adler and Ronda (2017) explain as follows:
The framework is not a typical template for lesson planning. We know that teachers write lesson plans in many different ways. In our lesson study work, we ask teachers to present their plan within the framework template. What this requires, first and foremost, is that the lesson has an explicit goal – what we call the object of learning. What are learners to know and be able to do as a result of participating in this lesson? The planned examples and their order, as well as what kinds of explanations will be built, and what learners will do are then all developed to meet the overall lesson goal. The teacher who will teach the lesson writes these further plans into the template.

(Adler & Ronda, 2017, Notes 1, para. 1)

In another study, Ono and Ferreira (2010) investigated continuing teacher professional development through lesson study in South Africa through the case of the Mpumalanga Secondary Science Initiative. The professional development of in-service teachers was considered, and traditional development efforts were reviewed. Lesson study was proposed and discussed as an alternative form of professional development to investigate whether the Mpumalanga Secondary Science Initiative could be a model for the rest of South Africa. The study reported that teachers who were involved in lesson study had improved their lessons and suggested that, with time, a culture of lesson study could be established in schools to benefit newly qualified teachers entering the profession.

However, Mpumalanga experienced challenges that may also apply in other African countries. For example, Ono and Ferreira (2010) stated that lesson study was initially started in 2001 but could not be practised again in the workshops until 2007. The National Department of Education had barred all workshops during the school term because of poor matriculation results. Therefore, the CPD activities were to take place during school holidays. However, various training workshops competed for training time, which complicated the involvement of teachers in lesson study workshops.

In addition, the introduction of the curriculum change, namely, the National Curriculum Statements, required teacher preparation in the period 2003–2005. Mpumalanga Province had to hold many training sessions to prepare teachers for implementation of the new curriculum. Moreover, the lesson study workshops and the National Curriculum Statements workshops did not complement each other (Mpumalanga Department of Education, University of Pretoria & Japan International, cited in Ono & Ferreira, 2010). Furthermore, Ono and Ferreira
(2010) stated that the lesson study project in Mpumalanga faced some challenges inherent in the project design, such as more subjects, a large number of schools to cover, as well as constraints imposed by education policies.

2.5.5 Lesson study in Zambia

As stated in Chapter 1 of this thesis, lesson study was introduced in Zambia in 2005. Zambia, with the help of JICA, implemented the School-based Continuing Professional Development Project (SMASTE) in two phases. Phase I (2005-2007) was for Grade 8-12 science teachers in the Central Province, and Phase II (2008-2011) for all the teachers in the Central Province and Grade 8-12 science teachers in Copperbelt Province and North-west Province. The two phases established the expansion model of lesson study, developed the Teaching Skills Book (MOE & JICA, 2009) and the Implementation Guidelines (MOE & JICA, 2010b), and trained the leaders of lesson study implementation.

Zambia implemented the Strengthening Teachers’ Performance and Skills through School-Based Continuing Professional Development (STEPS) project from November 2011 to December 2015 in order to introduce lesson study to all ten provinces in the country. STEPS also introduced the concept of kyozaikenkyu, a significant part of lesson planning in Japan, to help teachers improve their lessons and to promote learning for students, with MESVTEE and JICA (2015) stating that teachers should prepare a lesson by studying students and learning materials carefully and meticulously. Other essential features of lesson study included observation of the lesson, focussed on student learning rather than the teacher, and holding a post-lesson discussion to discuss, among other things, students’ solutions.

In 2016, the Zambian Ministry of General Education (MGE) and JICA published a brochure, Lesson study in Zambia for effective teacher professional growth and improvement of student learning (MGE & JICA, 2016). The brochure provided information about Zambian lesson study, as well as reasons for its introduction in Zambia, its processes, the way it was supported by policies and scaled up, and the effects of lesson study on teacher skills, student learning and pass rates at national examinations.

Two impact assessments of lesson study were conducted, the first in 2010 (MOE & JICA, 2010a) and the second in 2015 (MESVTEE & JICA, 2015). The 2010 study was conducted in the Central Province. It assessed the impact of the School-Based Continuing
**Professional Development Programme (SBCPD) Through Lesson Study** on the results of national examinations in Central Province, teachers’ attitudes, teaching processes, and students’ attitudes, and background factors that had made an impact on the effects identified. The participants comprised 29 head teachers, 23 lesson study facilitators, 136 science teachers, and 280 Grade 12 students. The research design used both the quantitative and qualitative methods. The quantitative part of the impact assessment was based on data collected from the Examinations Council of Zambia (ECZ). The qualitative data for the impact assessment (i.e., a questionnaire to school head teachers, lesson study facilitators, science teachers, and students) were analysed. The assessment claimed that SBCPD implementation had a positive impact on student achievement, especially on the pass rate for the national examination in science. The 2015 study, which had similar aims to the 2010 study, claimed that lesson study had helped teachers to improve their skills and knowledge in their subject; and develop a positive attitude towards mathematics and its teaching. The study also claimed that lesson study had helped students to develop a positive attitude towards mathematics and that their pass rate in national examinations had improved.

In her article, *Getting millions to learn: How did Japan’s Lesson Study program help improve education in Zambia?* Robinson (2015) stated that four features stood out from lesson study in Zambia: ensuring national ownership and sustainability; taking a phased, long-term approach; approaching teaching as a learning process; and changing mindset from training to supporting learning. According to Robinson (2015), to ensure national ownership of lesson study, the Zambia government did not impose, but rather invited lesson study as part of a response to the countrywide reforms aimed at improving the quality of teaching. She added that lesson study did not require building new and costly structures for implementation because it worked through existing organizational structures for school-based training programs. She stated further that JICA gave continuing support through periodic training for lead teachers, education officers, and school heads, and the development of instructional materials. She also noted that the largest portion of the budgetary assets for actualizing lesson study across the nation originated from the Zambian government. Since its inception, lesson study had been designed to complement the existing Ministry of Education in-service training programme, rather than as an external, short-lived donor project.

Robinson (2015) stated that in Zambia the long-term commitment and phased
approach by all partners had been an important aspect of lesson study’s success. She noted that it took a systematic approach over ten years to roll out lesson study in all provinces in Zambia. The expansion of lesson study followed the *School-Based CPD Master Plan* (MOE & JICA, 2010c) designed by the Zambian government for the period of 2006-2023. The fact that JICA had remained a constant partner throughout these 10 years contrasts with the average donor engagement of 613 days from start to completion (Robinson, 2015).

Robinson (2015) also stated that changing mindset from training to supporting learning helped lesson study to be scaled up in Zambia. According to Robinson, the mindset that the *trainers* are not lecturers or professional facilitators but teachers themselves might be one of the keys for scaling up the practice to large numbers of teachers. Teachers are regarded as the key change agents, regardless of their existing knowledge and skills.

Apart from the positive effects of lesson study reported in some studies, others have raised concerns about the way lesson study has been adapted. For example, Fujii (2014), a Japanese researcher and educator, analysed the data gathered during visits conducted by the *International Math-teacher Professionalization Using Lesson Study* (IMPULS) project and JICA to Uganda and Malawi. He highlighted misconceptions about lesson study that seem to be common outside Japan. These misconceptions related to the treatment of lesson study as a workshop, the need for strict adherence to the lesson plan, and observations focussing on the teacher instead of the teaching.

In their paper, *Teachers’ institution and participation in a lesson study project in Zambia: Implication and possibilities*, Baba and Nakai (2011) compared lesson study conducted as a voluntary activity (lesson study approach) and institutionalised lesson study, which is conducted according to prescribed procedures (institutional approach). Institutionalisation of lesson study in Zambia refers to its embedding into the existing *School Programme of In-service for the Term* (SPRINT) structure, introduced in 1996. The Ministry publication *The School-Based Continuing Professional Development through lesson study: Implementation Guidelines* (MOE & JICA, 2010b), defined SPRINT as a school-based system of continuous professional development for teachers based in schools and supported by Teachers’ Resource Centres and In-service Co-ordinators. The system involves small Teacher Group Meetings that meet on a regular basis to discuss professional issues. (MOE & JICA, 2010b, p. 3)
Banda (2007) stated that when formulating the *Strengthening of Mathematics, Science and Technology Education, School-Based CPD (SMASTE-CPD)* project to introduce lesson study in Zambian schools, the Ministry prioritized the need to utilize the existing programme and organization. The *Implementation Guidelines* stated that

The Ministry of Education is committed to strengthening and consolidating the school and college-based CPD programmes as contained in the Fifth National Development Plan (FNDP). This is the reason why the implementation of the SMASTE SBCPD in Central, Copperbelt and North-western provinces has been fully supported. One of the objectives of the SMASTE School-Based CPD is to improve teaching and learning in the classroom through focusing not only on the lesson preparations through Lesson Study, but also and most importantly, taking cognisance of the supportive role that education managers at various levels of the system and in-service co-ordinators play. (MOE & JICA, 2010b, p. iii)

Similarly, Jung, Kwaku, Nuran, Robinson, Schouten and Tanjeb (2016, p. 14) stated that

Lesson Study’s low price tag along with its customisation facilitated its eventual institutionalisation within the national education system, helping to build a strong sense of ownership over the program (by teachers, school managers, and government officials) in ways that made the government more inclined to support the program [sic] financially over the long term, to invest in its design and implementation, and to replicate the model in more schools and provinces. (Jung, Kwauk, Nuran, Robinson, Schouten & Tanjeb, 2016, p. 14)

As JICA’s World (2015, p. 5) reported, “Zambia is one of the few countries in Africa where the lesson study is incorporated into a system”.

Baba and Nakai (2011) found a notable difference between lesson study in Zambia and Japan concerning a common understanding of the target lesson to be realised through lesson study. They stated that although Zambian counterparts described the lesson as *learner-centred*, as written in *Educating Our Future: National Policy on Education* (MOE, 1996), few were able to articulate clearly what was meant by a *learner-centred* lesson beyond theory. Therefore,
It is not that they use lesson study as a means to attain the clear objective of an ideal lesson. Rather having some ambiguity in the objective or target image, they conduct lesson study by trial and error and at the same time explore an image of the ideal lesson and lesson study. (Nakai & Baba, 2011, p. 59)

Thus, while the lesson image was absent at the start, it is slowly being created and shared among teachers during research lesson implementation, observation, and reflection of practical experiences (Nakai & Baba, 2011).

In Zambia, Baba and Nakai (2011) studied the institution and autonomy in the nationwide dissemination of lesson study. They noted conflicts between institution-focused approach and lesson study approach shown in Table 2.2.

Table 2.2 Institution-focused approach and lesson study approach (Source: Nakai & Baba, 2011, p. 57)

<table>
<thead>
<tr>
<th>Institution-focused approach</th>
<th>Lesson study approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who</td>
<td>Education planner (Administrator)</td>
</tr>
<tr>
<td>What</td>
<td>Policy development</td>
</tr>
<tr>
<td>Characteristics</td>
<td>Stability, expectability, uniformity</td>
</tr>
<tr>
<td>How</td>
<td>Top-down, law, policy</td>
</tr>
</tbody>
</table>

According to Baba and Nakai (2014),

Institutionalisation helped people in introducing and extending practice to nationwide, especially with uniformed format and tools; however, it does not always guarantee a quality of practice, if implementers think they conduct a lesson study because it is requested or forced without understanding the necessity and thus having sense of autonomy. In Zambia, in the process of spreading the lesson study to the whole nation, these incidences of non-autonomous participation were observed. (p. 335)

To overcome this problem of non-autonomous participation, the Ministry in
2012 formed two six-member kyozaikenkyu (KK) teams one for mathematics and the other for science (Baba & Nakai, 2014). The expertise of the two KK teams were developed through the activities shown in Table 2.3.

Table 2.3 Planned activities for developing professional group (Source: Baba & Nakai, 2014, p. 336)

<table>
<thead>
<tr>
<th>Year</th>
<th>Activity for KK Mathematics team (6 members)</th>
<th>Activity for KK Science team (6 members)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>· Lesson study workshop supported by Japanese experts</td>
<td>· JICA Training Program for kyozaikenkyu (1) in Japan</td>
</tr>
<tr>
<td></td>
<td>· JICA Training Program for kyozaikenkyu (1) in Japan</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>· Lesson study workshop supported by JICA short-term experts</td>
<td>· JICA Training Program for kyozaikenkyu (1) in Japan</td>
</tr>
<tr>
<td></td>
<td>· JICA Training Program for kyozaikenkyu (2) in Japan</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>· Lesson study workshop supported by JICA short-term experts</td>
<td>· Lesson study workshop supported by JICA short-term experts</td>
</tr>
<tr>
<td></td>
<td>· JICA Training Program for kyozaikenkyu (2) in Japan</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>· Lesson study workshop supported by JICA short-term experts</td>
<td>· JICA Training Program for kyozaikenkyu (2) in Japan</td>
</tr>
<tr>
<td>(Planned)</td>
<td>· Lesson study workshop supported by JICA short-term experts</td>
<td>· Lesson study workshop supported by JICA short-term experts</td>
</tr>
<tr>
<td></td>
<td>· JICA Training Program for kyozaikenkyu (2) in Japan</td>
<td></td>
</tr>
</tbody>
</table>

The activities were “intended for KK team members to acquire basic knowledge and skills of kyozaikenkyu, realize them at classroom and deepen them with practical experience” (Baba & Nakai, 2014, p. 336). As a result, KK team members have been continuously working as core technical personnel for extending lesson study to schools and improvement of mathematics and science lessons and lesson study.

Baba and Nakai (2014) noted the challenges that KK teams were facing in disseminating knowledge and skills on kyozaikenkyu at schools, district, province and national levels. The first challenge was that KK teams found it difficult to break teachers’ current practices. Teachers did not want to study subject content they believed they had previously mastered, nor analyse students’ ideas and understanding. The second challenge was that KK team members had doubts about the effectiveness of the cascade approach used to disseminate ideas on kyozaikenkyu and teaching methods. They were sceptical that teachers who attended the workshops returned to their schools and shared what they learnt about kyozaikenkyu. Further
to this the KK teams admitted that they themselves had not yet mastered *kyoaikenkyu*, with Baba and Nakai (2014) stating, “considering this fact, it would be necessary for the teachers for teachers to continue their *kyoaikenkyu* practice for certain years of time with trials and errors” (p. 339).

Generally, the search of online literature by the researcher revealed that literature on lesson study in Zambia is limited (e.g., Baba & Nakai, 2011; Banda, Mudenda, Tindi & Nakai, 2014; MOE & JICA, 2010a; Sinyangwe, Billingsley & Dimitriadi, n.d.).

### 2.5.6 Implications for this research

The literature on adaptations of lesson study in non-Japanese countries offer insights into the affordances and constraints faced by Zambia in implementing lesson study and informs the research questions presented later in this chapter.

### 2.5.7 Summary of the literature

The Zambian Ministry of Education introduced lesson study in mathematics to help address the three primary areas of mathematics education had been identified as requiring reform: teacher-centred instruction, the mathematics curriculum, and continuing professional development of mathematics teachers (MOE, 1996).

The review of the literature on professional development found key characteristics of high-quality professional development to include it being: teacher-driven, coherent and integrated, and self-evaluative; continuing, extended, and collaborative; inquiry-based and part of teachers’ daily work; as well as being content-focused and informed by student performance – features which are recognised as being embodied by Japanese Lesson Study.

Within Japan, lesson study has evolved for over a century and is regarded as a process in which teachers strive to improve their teaching methods, working with other teachers to examine and critique their teaching. While Japanese descriptions of lesson study have only come about recently because of world-wide attention to lesson study, lesson study has often been described by non-Japanese observers as comprising four phases: a study of the curriculum and the formulation of goals; collaborative planning of a research lesson; conducting and observing the research lesson; and reflecting on student learning in the research lesson and the lessons that can be learned through this process. According to Takahashi and McDougal,
(2016), essential features of effective lesson study are that: the aim of lesson study is for teachers to build expertise and learn something new, not to refine a lesson; it is part of a highly structured, school-wide process; significant time is spent on kyozaikenkyu; the cycle is completed over several weeks rather than hours; and that knowledgeable others contribute insights throughout the process.

A common feature of Japanese mathematics lessons (particularly research lessons) is that they follow a pattern that has been described as “structured problem solving”, comprising: the presentation of a single, problem; individual or group problem solving by students; whole-class discussion of students’ solutions; and a summary by the teacher. Structured problem-solving lessons are designed to create interest in mathematics and stimulate creative mathematical activity, however a main focus is to develop students’ mathematical concepts and skills.

Over the last two decades, Japanese Lesson Study has been adopted and adapted in many countries, including a number of African countries. However, Zambia is one of the only countries (if not the only country) where its universal implementation has been mandated to occur in every government school. In countries such as the USA, England, Australia and South Africa, many relatively small-scale (and a few larger) lesson study projects have been supported through research or government funding. In particular, the adoption and adaption of lesson study in various African countries dates back to the late 2000s, with the Japan International Co-operation Agency (JICA) initial training and financial resources motivating many countries to develop projects for strengthening mathematics and science education through lesson study.

Attempts to incorporate essential features of Japanese Lesson Study have varied, with a number of projects deciding a priori to dispense with certain features – for example, the presence of observers other than members of the planning team at the research lessons.

While many positive effects of lesson have been observed, it appears that lesson study has often succeeded because of the assistance of local university-based educators, research funding, or the involvement of Japanese experts willing to engage in joint lesson study one or more times each year – particularly in African countries.

The literature has also highlighted many challenges for implementing lesson study. These include: teachers’ heavy teaching loads; difficulties in timetabling meeting times and releasing teachers to attend research lessons as observers; as well as finding suitable problem-
solving tasks to match the curriculum. Further challenges were posed by teaching cultures that emphasises small group rather than whole-class teaching, and teachers seeing the lesson study as another imposition on their already crowded day.

The extent to which lesson study in mathematics outside of Japan uses a structured problem-solving approach is not clear, especially when some projects focussed more on students developing mathematical problem-solving skills, rather than the development of mathematical content knowledge.

According to Robinson (2015), Zambia has taken a systematic approach to roll out lesson study in all provinces in Zambia over ten years. However, Baba and Nakai (2011) stated that although Zambian counterparts might describe lessons as learner-centred, few were able to articulate clearly what was meant by a learner-centred lesson. However, they believed that an image of a learner-centred lesson was slowly being created and shared among teachers during research lesson implementation, observation, and reflection.

This review of the literature has been used to help frame the research questions that will be addressed in this study.

### 2.6 Research questions

This research examines the implementation of lesson study in mathematics in Zambia. The overarching research question is:

**RQ:** How is lesson study in mathematics being implemented in Zambia?

This overarching question will be answered using the following subsidiary questions:

**SQ1:** How is lesson study in mathematics defined by the Zambian Ministry of Education, and interpreted by in-service providers, school administrators, and teachers of mathematics?

**SQ2:** What mechanisms have been put in place to support lesson study?

**SQ3:** How is lesson study being implemented at the school level?

**SQ4:** What has been the effect of the implementation of lesson study in mathematics in Zambia?
2.7 Significance of the Research

This research will contribute to the body of knowledge about adoption and adaptation of lesson study outside Japan, by examining the implementation of lesson study in mathematics in Zambia. It will extend the theoretical, methodological, and empirical understanding of lesson study in developing countries, especially in Sub-Saharan countries such as Zambia. In terms of its scope, this research will provide a basis for further study and exploration as well as stimulate a better understanding of lesson study in Zambia and other developing countries.
Chapter 3 Methodology

This research aims to investigate the implementation of lesson study in mathematics in Zambia. It is important to adopt a methodology that is appropriate to the research questions. This chapter covers Crotty’s theoretical framework as it relates to this study, case study methodology, the Onion Rings Model, and the research process.

3.1 Crotty’s theoretical framework

According to Crotty’s (1998) framework shown in Table 3.1, research should be guided by the researchers’ epistemological perspective, their theoretical perspective, methodology, and methods, which together “can help to ensure the soundness of our research and make its outcomes convincing” (p. 6).

Epistemology, according to Crotty, denotes the theory of knowledge underlying the research, while the theoretical perspective presents the specific philosophical position providing a context for the research. On the other hand, methodology provides the overall strategy, or plan of action, for conducting the research, and the methods, the means of data collection and analysis.
Table 3.1. Crotty’s theoretical framework for research (Source: Crotty, 1998, p. 5)

<table>
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<th>Theoretical perspective</th>
<th>Methodology</th>
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<td>Objectivism</td>
<td>Positivism (and post-positivism)</td>
<td>Experimental research</td>
<td>Sampling</td>
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<td>Constructivism</td>
<td>Interpretivism</td>
<td>Survey research</td>
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<td>Subjectivism (and their variants)</td>
<td>Symbolic interactionism</td>
<td>Ethnography</td>
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<td>Phenomenology</td>
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<td>Hermeneutics</td>
<td>Heuristic inquiry</td>
<td>• Participant</td>
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<td>Critical inquiry</td>
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<td></td>
<td>Feminism</td>
<td>Discourse analysis</td>
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<td>Postmodernism etc.</td>
<td>Feminist standpoint research</td>
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<td>Cognitive mapping</td>
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<td>Content analyses</td>
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Gray (2009) states that there is an interrelationship between the researcher’s epistemological perspective, their theoretical perspective, methodology, and methods:

Despite the natural tendency for the researcher (and especially the novice researcher) to select a data gathering method and get on with the job, the choice of methods is influenced by the research methodology chosen. This methodology, in turn, is influenced by the theoretical perspectives adopted by the researcher, and, in turn, by the researcher’s epistemological stance …whether they are aware of it or not. (p. 19)

3.1.1 Epistemology

The epistemology guiding the methodology for this research can best be described as Constructivism. Unlike Objectivism, which claims that “things exist as meaningful entities independently of consciousness and experience, that they have truth and meaning in them as
objects” (Crotty, 1998, p. 5), or Subjectivism which holds that reality is not a firm absolute, but a fluid, indeterminate realm which can be altered, Constructivism holds that:

Truth and meaning do not exist in some external world but are created by the subject’s interactions with the world. Meaning is constructed not discovered, so subjects construct their own meaning in different ways, even in relation to the same phenomenon. Hence, multiple, contradictory but equally valid accounts of the world can exist. (Gray, 2009, p. 20)

Thus, socio-cultural-constructivists (e.g. Dahms, Geonnotti, Passalacqua, Schilk, Wetzel & Zulkowsky, 2007; Hamza & de Hahn, 2012; Vygotsky, 1978) hold the belief that cultures, and societies provide people with the cognitive tools to construct and internalise meanings.

3.1.2 Theoretical Perspectives

The second component of Crotty’s (1998) schema is theoretical perspective. This research employs Interpretivism as its theoretical perspective. This perspective is founded on the belief that reality is socially constructed and fluid. As Howe (1998, p. 14) states, “knowledge, particularly in social research, must be seen as actively constructed and accordingly, as not neutral but culturally and historically contingent, laden with political values and serving certain interests and purposes”. In this vein, what we know is continuously negotiated within cultures, social settings, and relationships with other people.

An interpretivist theoretical perspective on teacher professional development has its origins in a socio-cultural theory of learning (Cammarota, Moll, Gonzalez & Cannella, 2013; Ellis, Edwards & Smagorinsky, 2010). Within socio-cultural theory, we have situative theorists who conceptualise learning as changes in participation in socially organised activities, and individuals’ use of knowledge as an aspect of their participation in social practices (Greeno, 2003; Lave & Wenger, 1991; Peressini, Borko, Romagnano, Knuth & Willis, 2004). Thus, many scholars – for example, Cobb, Stephan, McClain, and Gravemeijer (2011), as well as Driver, Asoko, Leach, Scott, and Mortimer (1994) – have reasoned that learning comprises both individual and socio-cultural features, thereby regarding the learning process as enculturative and constructive.

An interpretivist theoretical perspective has been applied widely in educational
research (e.g. Borko, 2004; Cobb et al., 2011; Nel, Engelbrecht, Nel & Tlale, 2013), with Boko (2004) stating that researchers “can use socio-cultural conceptual frameworks … to examine the social context of the classroom and patterns of participation in learning activities” (p. 4).

3.1.3 Case Study Methodology

This research uses case study methodology. As stated by Yin (2014), Stake (2013), and Merriam (1998), case study methodology is suitable when the research focuses on answering “how” and “why” questions, the context of the research is unique, and the researcher has little or no control over the behaviour of participants. These and many other arguments make case study methodology appropriate for this research as it seeks to answer the question of “how” lesson study is implemented in mathematics, in the Zambian context. Many scholars propose case study as the best option when an in-depth understanding of contextualised programmes is required (Merriam, 1998; Stake, 2013; Yin, 2014).

The process, context, and discovery are at the core of case study methodology. Merriam (1998, p. 19) stated that “The interest is in the process rather than outcomes, in context rather than a specific variable, in discovery rather than confirmation”. Case study methodology helps researchers to “study complex phenomena within their contexts” (Baxter & Jack, 2008, p. 544).

The advantage of using a case study design is that it provides an orderly way of studying events, collecting data, analysing information and reporting the results, and entails a detailed and intensive analysis of a single case (Bryman, 2012). Furthermore, case study approaches “account for and include difference – ideologically, epistemologically, methodologically and most importantly, humanly. They do not attempt to eliminate what cannot be discounted” (Shields, 2007, p. 12).

However, a case study approach has its limitations. Bell (2010) stated that a focus on a single case could make it difficult to cross-check information. Also, case studies have limitations of reliability and validity. Hamel, Dufour, and Fortin (1993), for example, stated that case study has been faulted for its lack of representativeness ... and its lack of rigour [sic] in the collection, construction, and analysis of the empirical materials that give
rise to this study. This lack of rigour is linked to the problem of bias ... introduced by the subjectivity of the researcher and others involved in the case. (p. 23)

Similarly, Yin (2014) stated that case studies suffer from a lack of external validity, partly because of the small samples associated with them. To lessen the limitations of a case study design, data should be collected through multiple sources. This increases confidence in the interpretation of data, confirms the validity of study processes, and reduces biases that may arise from using one method (Denzin & Lincoln, 2011).

### 3.2 The Onion Rings Model

Regarding the use of models in research, Hoffman and Monroe (2001) argue that a good model should be simple enough to understand yet complicated enough to accurately reflect the process it was designed to represent. In light of this, the model that seems likely to best reflect lesson study implementation in Zambia is the *Onion Rings Model*. This model has been used in educational research (Buchanan, 2012; Curry, 1983; European Commission, 2011; Lárusdóttí, 2014; Sadler-Smith, 1996) in other fields (Djanatliev, Bazan, & German, 2014) with the European Commission stating that “literature on educational effectiveness seems to outline a conceptual framework that can be described as an ‘Onion Rings’ model, going from the micro-level to the macro-level perspective” (p. 3).

In his paper on teacher learning, *An Organisation of Learning Styles Theory and Constructs*, Curry (1983) aimed to address the bewildering confusion of definitions surrounding learning style conceptualisation, and the wide variation in the scale of behaviour claimed to be predicted by learning style conceptualisations. Curry outlined a technical reorganization of learning style constructs and proposed an empirically testable structure (the Onion Rings Model with three rings) encompassing learning style concepts that had established psychometric standards. The three rings Curry used to conceptualise teacher learning style theories were the *Instructional format preference* (outer ring), *Information processing style* (the middle ring) and the *Cognitive personality style* (inner ring). In his conclusion, Curry argued that the Onion Rings Model was important in conducting educational studies:
This theoretical reorganization of the concept of learning styles is offered as one empirically testable step toward making learning style measurement available in a valid and reliable form for application in both manpower and educational studies. (Curry, 1983, p. 19)

Curry’s (1983) onion rings model was later developed by Sadler-Smith (1996), proposing that a more appropriate and all-inclusive term is “personal style”, which may be thought of as consisting of several distinct but complementary attributes – the various layers of the “onion” in Curry’s model. Sadler-Smith (1996) replaced the terms for the three onion rings in Curry’s model as follows: *Instructional format preference* (outer ring) by *Learning preferences*; *Information processing style* (the middle ring) by *Learning style*; and *Cognitive personality style* (inner ring) by *Cognitive style*. In addition to these terms, Sadler-Smith (1996) added three terms as shown in Figure 3.1.

![Figure 3.1. The six-layer “onion ring” model of learning style (Sadler-Smith, 1996, p.186)](image)

The Curry and Sadler-Smith models suggest that inner rings are related to personality and are stable, with the layers becoming more affected by environment as they move outwards from the centre of the onion. Sadler-Smith (1996) described the constructs in Figure 3.1 as follows.

- *learning preference* - the favouring of one particular mode of teaching over another;
- learning strategy - a plan of action adopted in the acquisition of knowledge, skills or attitudes through study or experience;
- learning style - a distinctive and habitual manner of acquiring knowledge, skills or attitudes through study or experience;
- cognitive strategy - a plan of action adopted in the process of organising and processing information;
- cognitive style - a distinctive and habitual manner of organising and processing information. (p. 186)

Further to this, Sadler-Smith (1996) argued that, “attending to personal style in the holistic way suggested will result in more efficient and effective learning” (p. 30).

In addition, Onion Rings Models have been used in fields outside education. For example, Djanatliev et al. (2014) showed how an abstract Onion Rings Model could be used to calculate the response times of rescue vehicles.

The Onion Rings Model used in this research is depicted in Figure 3.2. The rings need unpacking to deepen our understanding of the link between the model and the questions of this research. The rings in Figure 3.2 are nested within the Zambian national education system. The nested relationship of the five rings can enrich our understanding of how the implementation of lesson study at school level is shaped by Rings 1 to 4.
The use of the Onion Rings Model provides a practical means to study lesson study from a systemic, multilevel perspective. This conceptual model sees the micro-level of implementing lesson study at the core – embedded in the layers of teachers, school environment, and in-service providers – with the outer layer of the Ministry of Education at the macro level, with all five layers embedded in the Zambian national education system.

The Onion Rings Model discourages the treatment of the units of analysis (for example, the school environment) as independent. One effect of failing to recognise hierarchical structures of the implementation of lesson study in Zambia would be the understatement or overstatement of the research findings. Therefore, the use of the Onion Rings Model in this research increases the chance of making correct inferences from the findings, thereby providing reliable answers to the research questions.
3.2.1 The Zambian national education system

The Zambian education system has a 7-5-4 structure, namely 7 years at primary school, 2 and 3 years at junior and higher secondary school respectively, and 4 years at university for undergraduate degrees. English is the primary language of instruction in Zambian public schools. However, students also learn an additional local language, depending on their provincial district.

The secondary education is divided into two cycles: junior secondary, covering two years (grades 8 and 9), and the three-year senior secondary cycle (grades 10-12). Junior secondary ends with the students sitting their Junior Secondary School Leaving Examination (JSSLE), referred to as the Grade 9 examinations. These examinations prepare students to proceed to senior secondary, and the JSSLE Certificate is a pre-requisite for eligibility to register for examination at Grade 12.

For decades, the Zambian education system had been characterised by the persistent poor student performance in mathematics at Grades 7, 9 and 12 national examinations. As already stated in Chapter 1 of this thesis, the Ministry affirmed that persistent poor student performance in mathematics and science is a situation that:

requires urgent attention and major interventions. The students themselves and the country as a whole cannot sustain a continuation of this unsatisfactory performance in mathematics and science, leading to equally unsatisfactory performance in the School Certificate as a whole and subsequent impairment of the national potential for technological development. (MOE, 1996, p. 53)

Therefore, the Ministry identified three primary areas of mathematics education that require reform: teacher-centred instruction, the mathematics curriculum, and continuing professional development of mathematics teachers (MOE, 1996). In this vein, the Ministry has introduced lesson study in Zambian education system to transform the teacher-centred lessons to student-centred lessons, and to enhance continuing professional development of mathematics teachers (MOE & JICA, 2010a).
3.2.2 Ministry of Education

The outer ring denotes the national policy on education, at both Federal and State levels. The European Commission (2011) observed that recent research on national education systems concentrates on the effects of decentralisation and school autonomy, as well as evaluation and accountability mechanisms, both of which have implications for continued professional development and teacher quality.

The Onion Rings Model helps to explain the meaning, nature, and challenges associated with national policies on lesson study in Zambia. The World Bank (2012), for example, advocated frameworks that aim to “map the policies a given education system puts in place to manage its teaching force” (p. 3). In my study, the Onion Rings Model guides the evaluation of policies on lesson study in Zambia. For example, data were collected on issues regarding the perceived role of lesson study in addressing national challenges in mathematics education, as set out in policy documents, and directives on lesson study implementation, as well as evaluation mechanisms.

3.2.3 In-service providers

The second ring denotes a focus on the activities of the In-service providers, the District Education Board Secretaries, the District Education Standards Officers, and their interpretations of Zambian lesson study in mathematics as defined by the Ministry of Education, as they have a mandate to provide in-service and ensure that schools are implementing lesson study.

The ring focuses the nature and adequacy of support the in-service providers render to school administrators and teachers and the challenges they face.

3.2.4 School environment

The third ring signifies a focus on the school culture, especially on school leadership, teacher collaboration, staff relationships and communication, and the opportunities for teacher professional development (European Commission, 2011).

As already stated in the literature review, the school culture promotes or hinders teacher professional development to a considerable extent (Imants, 2003). The interpretivist theoretical perspective posits that schools, as professional communities, are the most favourable
places for teachers’ professional learning (European Commission, 2011; Putnam & Borko, 2000; Sleegers, Bolhuis & Geijsel, 2005), with the European Commission (2011) stating that this view is strong because it takes notice of

past failures of … “one-shot” professional development approaches, adopting instead a change as professional learning perspective … according to the paradigm of the teacher as reflective practitioner, taking responsibility for learning to improve the quality of professional performance. (European Commission, 2011, p. 4)

Ring 3 also denotes the classroom environment – the student-teacher ratio, the physical and pedagogical aspects. Student-teacher ratios vary across Zambia, with the Copperbelt Province having the ratio of 44 in 2013, and Luapula Province, 92 (MOE, 2014). Intuitively, lesson study groups in Copperbelt Province would face fewer challenges than those faced by their colleagues in Luapula Province.

Further, the physical aspects include desks, chairs, blackboard, light, air quality, temperature, and the state of the roof. Some studies have linked the physical classroom environment with student learning (e.g. Choi, Van Merriënboer & Paas, 2014; Sojoudi & Jaafar, 2012; Yang, Becerik-Gerber & Mino, 2013), with Yang et al. (2013) stating that unsatisfactory lighting in the classroom has negative impacts on student performance. Sojoudi and Jaafar (2012) found that some lighting sources, such as fluorescent, emitted x-rays, radiation and radio waves reduced student productivity and hyperactivity.

In this study, the Onion Rings Model helps to explore the relationship between the classroom environment and other rings.

3.2.5 Teachers

The fourth ring represents Zambian teachers as professionals and their pedagogies. Among other things the ring focuses on teachers’ qualifications and competencies, their beliefs and attitudes, the CPD in which they participate, and the challenges they face. There is extensive research about the relationship between teachers’ characteristics and effective professional development in general, and the success of lesson study in particular (e.g. Perry & Lewis, 2009; Remillard & Bryans, 2004), with Remillard and Bryans (2004) stating that the ways teachers “use curriculum materials are shaped by their knowledge of and views about mathematics” (p.
Perry and Lewis (2009) state that lesson study participants with more limited pedagogical content knowledge may be unable to explore curriculum ideas sufficiently.

Pedagogical aspects of the classroom environment refer to the instructional methods or the processes teachers use, so that their students learn (Anthony & Walshaw, 2009; Paswan & Young, 2002; Wood, Nelson & Warfield, 2014), with Paswan and Young (2002) stating that non-threatening instructional methods allow students to ask questions, practise free expression of ideas, develop their skills, and improve class discussion.

### 3.2.6 School level implementation of lesson study

The final ring denotes the actual activities during the lesson study cycle (i.e., planning, teaching, and observing the lesson, post-lesson discussions, and other follow-up activities, such as re-teaching of the revised lesson). The Onion Rings Model helps to explore in depth the relationship between Ring 5 and the remaining four rings.

### 3.3 The research process

This research explores the implementation of lesson study in mathematics in Zambia. The Onion Rings Model was used to address the four subsidiary research questions as shown in §2.5 in the previous chapter.

At the Ministry of Education level (Ring 1), documents from the Zambian Ministry of Education were analysed to establish how lesson study in mathematics has been defined for implementation in Zambia. Six high-ranking officers from the Ministry of Education, Science, Vacation Training and Early Education (MESVTEE) were interviewed to investigate the views of in-service providers (Ring 2) regarding both their interpretation of lesson study and the support mechanism put in place for its implementation in Zambia.

Three secondary schools participated in the case studies. At each school, two lesson study cycles were observed and video recorded (Ring 5). In Zambia, a lesson study cycle comprises planning, teaching, and observation of a research lesson, post-lesson discussion, and teaching of the revised lesson. Interviews were conducted at each school with the head teacher, the Co-ordinator for Continuing Professional Development, and the two mathematics teachers who taught the research lessons (Rings 3 and 4).
Grade 12 national examination results in mathematics before and after the introduction of lesson study were collected at participating schools to examine the performance of students in mathematics.

The methods used to analyse the data were thematic coding of the interview and observation data, ‘gisted’ transcription and coding of video data, and statistical analysis of Grade 12 national examination results.

### 3.3.1 Participants

Purposive sampling was used to invite participants in this study. The reason for using purposive sampling was to select “information-rich cases (participants) for in-depth study” (Merriam, 1998, p. 61) and to provide rich data for answering the research questions (Mills, Airasian & Gay, 2012; Petty, Thomson & Stew, 2012). According to Lincoln and Guba (1985, p. 200), “the person doing the study begins with the assumption that context is critical and purposely selects a sample … which [is] expected to provide a rich array of information.”

**In-service providers**

Eight in-service providers from the Ministry were interviewed. Six were directly responsible for the provision or monitoring of School-Based Continuing Professional Development (SBCDP) programmes, which Zambia was implementing through lesson study (MOE & JICA, 2009).

Two were drawn from Ministry headquarters, one officer was from the Directorate of Teacher Education and Specialized Services (TESS), which is responsible for the provision of in-service teacher professional development programmes, and the other from the Curriculum Development Centre (CDC).

At the district level, the District Education Board Secretary (DEBS) for each of two participating districts was invited to participate in the study. The DEBS ensure that all Ministry policies are implemented in the district. The District Education Standards Officer (DESO) for each of two participating districts was invited to participate in the study. DESOs inspect standards in schools including the implementation of lesson study.

The choice of the above participants was based on their suitability to provide information for an in-depth understanding of the link between Ministry policies and strategies
and the implementation of lesson study in mathematics.

**Participating schools**

Three government schools (School A – Southern Province – and Schools B and C – Central Province) participated in the study. At each school, two lesson study cycles were observed and video recorded.

The schools that participated in this study were selected based on the criteria that they would enrich the findings. The reasons for choosing School A, located in the Southern Province, were based on the following information gathered before inviting the school to participate in this study.

School A had relatively good school facilities, such as blackboards, that would enrich this study by investigating how such facilities were used during lesson study. In Japan, teacher’s recording of the progress of the lesson on the blackboard has a special name, *bansho*. As Doig and Groves (2011) state, “Japanese observers frequently take photographs of the blackboard, as it reveals to students and teachers alike the progress of the lesson, and the students’ responses. This helps to organise student thinking and model good organisation of notes” (pp. 83-84).

School A was expected to have relatively adequate instructional materials that teachers could investigate during research lesson planning. This expectation was because School A was better funded than some other government schools in the Southern Province. Therefore, School A would provide an opportunity to observe the amount of time the mathematics lesson study group spent investigating instructional materials.

Being a boarding school, it was assumed that students at School A were more available to engage in lesson study than students in day schools. The boarding aspect needed to be investigated, as it could potentially enable teachers to have more time to conduct lesson study.

School A had a record of 100% student pass rate at Grade 9 and Grade 12 national mathematics examinations. Such a case was important to this study to establish the attitude of these mathematics teachers towards participating in lesson study. If the propagation of the reasons for lesson study centred on improvements in student performance and neglected the aspect of teacher development, the teachers who produced 100% pass rates would have little motivation to participate in lesson study.

School B was invited to participate in this study mainly because of its long-standing
history of lesson study. A day school, located in Central Province with an enrolment capacity of 1000 on-campus students, School B had dilapidated infrastructure, with chalkboards in some classrooms almost impossible to write on. However, School B was one of the schools in which lesson study was first introduced in Zambia. Therefore, it was invited to participate in this study.

School C was invited because the Permanent Secretary for the Zambian Ministry of Education requested its inclusion in the study. The requests were made at the time I was obtaining approval from the Ministry to interview high-ranking MESVTEE officers, in-service providers, school administrators, teachers, and to observe lesson study cycles in schools. The Permanent Secretary stated that School C would be a good site for observing lesson study because one of its administrators was a member of the Zambian Kyozai-Kenkyu team (KK Team). There were two KK teams in Zambia, one for mathematics and the other for science. As a professional group with a certain level of autonomy both individually and as a team, the KK team held workshops and conducted lesson study in schools to overcome the lack of autonomy of teachers implementing lesson study (Baba & Nakai, 2014). It is against this background that the Permanent Secretary was convinced that School C, though a relatively new school, would have its lesson study activities deepened because its administrator was a member of the mathematics KK Team.

School administrators

Six school administrators (two from each of three participating schools) were invited to participate in this research. These were the head teacher and the person responsible for coordinating Continuing Professional Development. These two administrators at each school provided information for an in-depth understanding of the link between the school environment and lesson study in mathematics. They also provided information for the understanding of how they had interpreted the lesson study defined by the Ministry of Education for use in Zambia.

Teachers

The teachers who were invited to participate in this research were those involved in lesson study in mathematics at the participating schools. From the group of teachers observed during planning, teaching and observation of the lesson and post-lesson discussions, only two teachers at each participating school were interviewed because interviews are a time-intensive
research instrument (Kara, 2013; Valenzuela & Shrivastava, 2002). The teachers who taught the research lessons were the ones chosen for an interview. Typically, these teachers were the ones who had previous experience in teaching a research lesson. As Ritchie, Lewis, Nicholls, and Ormston (2013) state, “Sample units are chosen because they have particular features or characteristics which enabled detailed exploration and understanding of the critical themes and questions which the researcher wishes to study” (p. 113).

3.3.2 Data sources

This section presents the sources of data for this study.

Documents

Documents were collected from the Provincial Education Office, District Education Office and participating schools. The five documents outlined below were the key documents reviewed to establish how lesson study in mathematics was being implemented.

*School-Based CPD through Lesson Study/Teaching Skills Book* (MOE & JICA, 2009) – hereafter referred to as the *Teaching Skills Book*:

The *Teaching Skills Book* was based on lesson study experiences in the Central Province of Zambia. It was “aimed at not only providing appropriate teaching skills, but also to deepen the teachers’ knowledge and skills” (MOE & JICA, 2009, p. iii). It was “designed to benefit the key stakeholders such as teachers, facilitators and others who implement school-based programmes” (MOE & JICA, 2009, p. iii).

*School-Based Continuing Professional Development Implementation Guidelines* (MOE & JICA, 2010b) – hereafter referred to as the *Implementation Guidelines*:

The *Implementation Guidelines* were developed in 2010 based on experiences from lesson study activities under the *Strengthening Mathematics Science and Technology Education School-Based Continuing Professional Development* (SMASTE SBCPD) programme in Central, Copperbelt, and Northwestern Provinces. These guidelines were developed for “Teachers, Senior teachers, Deputy Headteachers, Head Teachers, Facilitators and all Stakeholders at various levels of the education system to use for effective implementation and management of the school-based CPD through lesson study” (MOE & JICA, 2010b, p iii).
School-Based CPD through Lesson Study/Management Skills Book (MOE & JICA, 2010c) – hereafter referred to as the Management Skills Book:

The Management Skills Book was developed to help key stakeholders of the programme at various levels such as the National Education Support Team (NEST), Provincial Education Support Team (PEST), District Education Support Team (DEST), Resource Centres Co-ordinators, and school managers. The book contains information on the management skills required to support teachers implement CPD activities, especially lesson study.


This report was based on the findings from an assessment of impacts of the SBCPD programme on students’ achievement and the factors promoting and hindering the SBCPD programme in Central Province. The report provided “information that can be used by the Ministry of Education, JICA, and other donors to gauge the effectiveness of the SBCPD programme and can inform decisions about the design of future programmes” (MOE & JICA, 2010a, p 2).


This report was based on stakeholders’ views on the impact of lesson study on learner performance, and background factors affecting its implementation. The stakeholders included Education Officers, Resource Centre Co-ordinators, head teachers, teachers, and students from three provinces. It aimed to provide information for the objectives of the Strengthening Teachers’ Performance and Skills (STEPS) project.

The goal of the current STEPS Project was the improvement of science and mathematics education, and the overall objective was to ensure that students’ learning process in science and mathematics is improved through enhancing teaching skills under lesson study. (MESVTEE & JICA, 2015, p. vi)
Additional documents that were collected include the new school curriculum and lesson plans for the mathematics research lessons from each participating school. Table 3.2 summarises the documents that were collected and shows which research questions were addressed through the document analysis.
Table 3.2. Summary of documents collected

<table>
<thead>
<tr>
<th>Source</th>
<th>Documents</th>
<th>Focus of information</th>
<th>Research questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry officers</td>
<td>The Teaching Skills Book (MOE &amp; JICA, 2009)</td>
<td>Definition of lesson study. The way lesson study is being implemented in schools. Mechanisms for supporting lesson study at district level</td>
<td>SQ 1, 3 &amp; 4</td>
</tr>
<tr>
<td></td>
<td>The Implementation Guidelines (MOE &amp; JICA, 2010c)</td>
<td>Definition of lesson study. The way lesson study is being implemented in schools. Mechanisms for supporting lesson study at the district level.</td>
<td>SQ 1, 3 &amp; 4</td>
</tr>
<tr>
<td></td>
<td>Grade 12 national examination results for three years before and three after the introduction of lesson study at participating school. (Examination Council of Zambia)</td>
<td>Changes in students’ performance</td>
<td>SQ 4</td>
</tr>
<tr>
<td>Source</td>
<td>Documents</td>
<td>Focus of information</td>
<td>Research questions</td>
</tr>
<tr>
<td>--------</td>
<td>-----------</td>
<td>----------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Participating Schools</td>
<td>School Curriculum</td>
<td>Definition of lesson study</td>
<td>SQ 1 &amp; 2</td>
</tr>
<tr>
<td></td>
<td>The Teaching Skills Book (MOE &amp; JICA, 2009)</td>
<td>Definition and interpretation of lesson study. Mechanisms for supporting lesson study at school level.</td>
<td>SQ 1, 2 &amp; 4</td>
</tr>
<tr>
<td></td>
<td>Mathematics lesson plans</td>
<td>Content of the research lesson. The way lesson study is being implemented in schools. Challenges</td>
<td>SQ 3</td>
</tr>
</tbody>
</table>

**Interviews**

Semi-structured interviews were used to collect data from participants from the In-service providers, school administrators, and teachers. Appointments were made to conduct the interviews on suitable dates. For ethical reasons, questions that might involve over-sensitive information were avoided, and data collected remains protected from access by third parties, with all interviewees identified by pseudonyms. The interviews were conducted in English, which is the official language and language of instruction in Zambia. Interviews were held during hours convenient to respondents at their official places of work. Each interview lasted approximately one hour and was audio recorded and transcribed.

**Video-recording**

Video-recording was used to collect data on the lesson study cycles. In Zambia one cycle comprises planning the research lesson, teaching the research lesson, observing the research lesson, the post-lesson discussion, and teaching of the revised lesson. Any students whose parents had not given consent, or who did not wish to be video-recorded, were moved to another classroom for that lesson. Six lesson study cycles were video-recorded (two cycles at each school).

Video-recording has been used widely in researching lesson study (Alston, Pedrick, Morris & Basu, 2011; Doig & Groves, 2011; Stigler, Gonzales, Kawanaka, Knoll & Serrano, 1999), with Alston et al. (2011, p. 137) adding that “One of the possible structures available to
lesson study is the use of video as a tool to enhance practitioners’ natural ability to reflect on their practice” (p. 137).

Field notes and research diary

Field notes were taken to provide contextual information for video-recorded data. As Dufon (2002) pointed out, video-recordings may lack important contextual data because they tell nothing about how typical the recorded event is, and whether it is frequent, unusual, or unique. She stated, “the researcher should triangulate with other methods of data collection to know something about the frequency, as well as other characteristics, of the event being recorded” (p. 44). In this vein, field notes provided contextual information on the lesson study events that were video-recorded.

Field notes are “fairly detailed summaries of events and behaviour and the researcher’s initial reflections on them” (Bryman & Bell, 2011, p. 441). Keeping good field notes is considered good practice for collecting data. Bryman and Bell (2011, p. 89) stated, “If participant observation is a component of your research, remember to keep good field notes and not to rely on your memory”. However, they cautioned that “scribbling notes on a continuous basis [by the observer] runs the risk of making people [the observed] self-conscious” (p. 445).

In addition, a reflective diary was kept of details of my experiences. Specifically, I entered daily schedules and logistics (when, where, and with whom interviews and observations were conducted); comments related to my views, beliefs, frustrations, joys, and speculations that emerged as I gained more insights; photographs of the schools; descriptions of unusual events or observations during each visit to the school or office, and justifications for any methods I chose to use. These activities enabled me to develop a deeper understanding of many issues raised by respondents, especially the teachers involved in lesson study.

Although a research diary can “conceptually and physically resemble other data collection methods” (Sheble & Wildemuth, 2009, p. 2), it differs because it requires researchers to make self-reports repeatedly over time (Bolger, Davis & Rafaeli, 2003).

Records of Grade 12 examination results in mathematics

All secondary schools in Zambia use the national syllabus, and Grade 12 students across the country sit for a national examination prepared by the Examination Council of
Zambia (ECZ). The ECZ marks the examination scripts and compiles and sends the results to schools.

Records of Grade 12 examination results in mathematics were collected from the participating schools. The results for 2011 and 2014 were collected at School A and School B. However, School C only opened in 2013, thereby having no results for 2011 or 2014 as the school was not yet an examination centre. Students from School C sat for Grade 12 examinations from other schools. However, School C became an examination centre in 2015. Therefore, its Grade 12 mathematics examinations results for 2015 and 2016 were collected. Also, the data on the Grade 12 examination in mathematics for Schools A and B were examined for the effects of lesson study on student performance in mathematics.

3.3.3 Data analysis

The textual and video data were analysed using computer-assisted qualitative data analysis NVivo (QSR International, 2014), and Transana (Fassnacht & Woods, 2001) while the Grade 12 results were analysed using the XLStatistics (Carr, 2014). I used both Transana and NVivo because Transana was user-friendly for analysing video data, and NVivo offered for more opportunities for exploring the textual data.

Textual data

The textual data – that is, the interview transcripts and the MESVTE documents – were analysed using NVivo. According to Adu (2016), the qualitative analysis process enabled through the use of NVivo is as shown in Figure 3.3.

Adu (2016) stated that NVivo features help to work on multiple data, run queries, code significant parts of data, add descriptions and memos (reflections) to the codes generated, create illustrations to better display your findings, and brainstorm ideas. (para. 2)
Figure 3.3. Qualitative analysis process using NVivo (Source: Adu, 2016)

In Figure 3.3, the coder’s findings (e.g. themes and models) not only represent the data but also reflect their subjective intent and thought process, background, and experiences. Therefore, to ensure credibility, the coder needs to be transparent in the coding process (Adu, 2016).

In my study, the first step was to create a project in NVivo, with files (interview transcripts, and policy documents) imported into the project as internals (see Figure 3.4 and Figure 3.5).
Figure 3.4. The interview transcript of MOE1 imported into NVivo
Second, nodes were created based on the research questions. A node is a term used by NVivo to represent a code, theme, or idea about the data the researcher wants to include in a project. Node hierarchies were created, moving from general topics (parent nodes) to more specific topics (child nodes). In Figure 3.6, for example, 1. MESVTEE high-ranking officers is a first order node, whereas Q3. Definition of Lesson Study is second order, and 3.3 What teachers learn in LS is third order. The aim of creating these levels of nodes is to reduce data to general themes in the research questions. According to Lincoln and Guba (1985), categorisation helps “to bring together into provisional categories those codes that apparently relate to the same content” (p. 347).

Third, the nodes were coded. According to Strauss (1987, p. 27), the “excellence of the research rests in large part on the excellence of the coding”. Codes, as defined by Huberman
and Miles (1994), are
tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study. Codes are usually attached to “chunks” of varying size – words, phrases, sentences or whole paragraphs. (p. 56)

Similarly, Saldaña (2009) states that

A code in qualitative inquiry is most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data. (2009, p. 3)

An example of coding is shown in Figure 3.7, where four codes (text tags) for the node 6.4 Challenges in quantifying LS effects are shown in the right-hand column.

![Figure 3.7. Coding the nodes in NVivo](image)

During coding, analytic memos were written to reflect on the data corpus. As Mason (2017) states, memo writing enables the researcher to one is doing and why, confronting and often challenging own assumptions, and recognizing the extent to which ones’ thoughts, actions
and decisions shape how one does research and what one sees.

In this vein, Weston, Gandell, Beauchamp, McAlpine, Wiseman, and Beauchamp (2001) state that coding and analytic memo writing are simultaneous qualitative data analytic activities, because there is “a reciprocal relationship between the development of a coding system and the evolution of understanding a phenomenon” (p. 397).

After intensive coding and memo writing, the data was systematically reduced to themes to address the research questions.

**Video data**

At each school (Schools A, B, and C) two lesson study cycles were observed and video-recorded. Transana computer analysis software was used to analyse the video data. The large volumes of video data were transcribed using *gisted transcription* (Dempster and Woods, 2011). Paulus, Lester, and Dempster (2013) stated that a gisted transcript is similar to a news show reports sharing the highlights of a politician’s speech and identified “two types of gisted transcript: condensed and essence” (p. 98). According to Evers (as cited by Paulus et al., 2013), a condensed transcript is created by listening to the recording and leaving out all the utterings that seem irrelevant to the research question. However, the major challenge with condensed transcription is “deciding what to leave out, while still retaining enough context for analytical purposes (Paulus et al., 2013, p. 98).

Whereas a condensed transcript captures the exact words from the media file, an essence transcript retains only a paraphrased version of recorded data (Paulus et al., 2013, p. 98). Essence transcribing, as stated by Dempster and Woods (2011), can help researchers to save time spent on creating transcript from media files as it enables the researcher to create a summary transcript that captures the essence of a media file’s content without taking the same amount of time or resources as a verbatim transcript might require. Typically ... a researcher may take four to five hours create a verbatim transcript of the spoken word in a typical hour-long media file, while such a file can be gisted in one to two hours. (p. 22)

The video data for this research were transcribed using, in essence, gisting. Figure 3.8 is an excerpt from the database in Transana, displaying the organisational structure of the data for lesson planning, teaching and re-teaching of the research lessons at the three case schools.
An excerpt of the database displaying data on the revision of the research lessons and the post-lesson discussion is not shown here.

Figure 3.8. Database for lesson planning, teaching and re-teaching

Figure 3.8 shows that the organisational structure of data in Transana database is in a tree form, comprising libraries, collections, keywords, and search. A library is a group of related source files (i.e., media or text files). In this study, five libraries were created based on the video recordings: planning the research lesson, teaching, revision of the taught lesson, re-teaching the
revised lesson, and post-lesson discussion. Video files for the three case schools were imported into respective libraries. For example, in Figure 3.8, under the library *Planning research lesson*, SA-P1 is the video file on the planning of the first research lesson at School A, and SA_P2 is the video file on the planning of the second research lesson at School A.

The video and audio files brought into Transana are called *Episodes*, and text files are called *Documents*. The *Episodes* can be associated with more than one transcript, and, therefore, researchers might decide to use multiple transcripts to summarise information about different analytic layers they wish to explore.

In Transana, a collection is a group of conceptually related bits of analytical data, which can be bits of text taken from *Documents*, segments of media taken from *Episodes* and Transcripts, or the still images related to the analysis. In this research, five Collections were created: planning the research lesson, teaching, revision of the taught lesson, re-teaching the revised lesson, and post-lesson discussion. The collections are nested. For example, the collections SA-P1 (School A – Planning 1), SB-P1 (School B – Planning 1), and SC-P1 (School C – Planning 1) are nested (contained) within *Planning-1*. In addition, *Planning-1* and *Planning-2* are nested within *Planning*. This sub-categorisation allowed considerable flexibility in specifying a meaningful analytic structure for clips and snapshots. In this vein, gisted clips and snapshots from videos for each case school were contained in respective collections.

The act of coding of clips and snapshots is central to analytic activities in Transana. The coding structure for this research was stored under the Keyword nodes. Keywords (that is, codes) were applied to the video clips and snapshots. The database in Figure 3.8 contains nine keyword groups. For example, *Observer activities* contain six keywords, as shown in Figure 3.8. These keywords were assigned to the video clips and snapshots to describe the analytically interesting content of the clip or snapshot.

Figure 3.9 refers to a video clip of the teacher explaining to the class during research lesson 1 at School A. This clip was assigned the keyword *Explaining* the keyword group *Teacher activity*. When keywords were assigned to a video clip, essential information was summarised in the transcript section of the clip properties. For example, in Figure 3.8 the transcript section summarised what the teacher said to the students.
Figure 3.9. Assigning a keyword to a video clip in Transana

Typically, the transcript was linked to the video clip as shown in Figure 3.9, allowing the researcher to explore the clip when needed.
Figure 3.9. A clip from teaching research lesson 1 at School A

After gisting an entire video, a number of reports were generated (Library reports, Keyword Summary reports, Episodic Reports, and the Collection reports), as well as the Episodic and Collection keyword maps. For example, the Episodic Keyword Map Report in Figure 3.10 is a visual display of the keywords assigned to the video for re-teaching research lesson 1 at School A.

Figure 3.10. Episodic Keyword Map Report for re-taught lesson 1 at School A

The reports and keyword maps were examined to gain a deeper understanding of the keywords as they relate to the research question on lesson study implementation at the school level. In Figure 3.10, for example, there is no band for Observer activities: Using lesson plan/checklist, indicating that observers did not use the lesson plan or checklist during the lesson. It is also evident from the (blue and yellow) band for Pupil activity: Presenting before the class, that approximately four minutes of the lesson was spent on students presenting their solutions or the strategies they had used to solve the problems.

Quantitative data

The Grade 12 mathematics examination data were analysed for the effects of lesson study on student performance using XLStatistics (Carr, 2014). The Grade 12 examination
results in mathematics for 2011 and 2014 at Schools A and B were analysed. School C, being a new school, did not have Grade 12 results for 2011 and 2014, but only for 2015 and 2016. The results were analysed but not compared with those for School A and B.

**Summary of data collection methods and analysis**

The data collection methods and analysis are summarised in Table 3.3. As can be seen from Table 3.3, this research used multiple sources of data, and a variety of methods to collect data. This approach helped to cross-check the consistency of data items from various sources. While qualitative and quantitative methods were used to analyse the data, their nature (e.g. size) affected the choice of methods for analysing each type. For example, because video data from six lesson study cycles were voluminous, gisted transcription was used in Transana to create summary transcripts that captured their essence (Evers, 2011), to reduce the number of hours spent transcribing.

Table 3.3. Summary of data collection methods and analysis

<table>
<thead>
<tr>
<th>Source</th>
<th>Focus of data</th>
<th>Data collection methods</th>
<th>Analysis</th>
<th>Research questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>MESVTEE high-ranking officers</td>
<td>Definition of lesson study; mechanisms for supporting lesson study; lesson study in schools; effects of lesson study.</td>
<td>Documents (MESVTEE policies, strategies and procedures) related to lesson study.</td>
<td>Transcriptation and Coding</td>
<td>SQ 1, 2, 3, 4</td>
</tr>
<tr>
<td>School administrators</td>
<td>Definition of lesson study; mechanisms for supporting lesson study; lesson study in schools; effects of lesson study.</td>
<td>Interviews</td>
<td>Transcriptation and Coding</td>
<td>SQ 1, 2, 3, 4</td>
</tr>
<tr>
<td>Mathematics teachers participating in the lesson study cycles</td>
<td>Lesson study cycle</td>
<td>Video-recording</td>
<td>Coding</td>
<td>SQ 1, 2, 3, 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gisted transcription and Coding</td>
<td>SQ 3</td>
</tr>
</tbody>
</table>
Table 3.3 also shows how data from various sources were used to answer the four research questions for this study.

### 3.3.4 Ensuring trustworthiness

Granger, Tseng, and Wilcox (2013) and Thomas, and Magilvy (2011) argue that we should assess the quality of case studies on “trustworthiness” and “authenticity”. Trustworthiness, as stated by Bryman (2012), consists of four criteria: credibility, which is similar to internal validity; transferability, which is similar to external validity; dependability, which is similar to reliability, and confirmability. Further, Bryman stated that authenticity addresses the wider political impact of the study, in particular: fairness of the study in representing different viewpoints among members of a social setting; ontological authenticity, denoting whether the study helps members to arrive at a better understanding of their social setting; educative authenticity, denoting whether the study helps members to appreciate better the perspectives of other members of their social setting; and catalytic authenticity, denoting whether the research acts as an incentive for the people being studied to participate in an action to change their conditions.

#### Credibility

Credibility, according to Merriam (1998), deals with the question: How congruent are the findings with the reality? Several steps were taken to enhance credibility. For example, to capture the exact views of the interviewees, their opinions were occasionally rephrased. Also, follow-up questions were asked for amplification. In addition, some respondents were contacted after the interview (by telephone or email) to validate their views when I was uncertain. For example, on three occasions, I phoned the two officers I had interviewed from the Ministry of Education to clarify issues in the documents. I observed and took note of the availability and state of facilities in classrooms, such as the chalkboard, and desks and chairs for students, as
these factors might affect the research lessons.

Transferability

Qualitative research findings are usually specific to a small number of particular environments and individuals, so it is difficult to ascertain whether these findings apply to other situations and populations (Silverman, 2013). However, Charmaz (2005) stated that the findings of good qualitative research “could be extrapolated beyond the immediate confines of the site, both theoretically and practically” (p. 528).

To allow others to assess how transferable the research findings are, Lincoln and Guba (1985) stated that researchers should provide dense background information about the informants and the research context and setting. The researcher should consider the data rather than the subjects by determining if the content of the interviews, the behaviours, and observed events are typical (representative) or atypical (not representative) of the lives of the informants (Krefting, 1991, p. 221).

This research documented background information about the context and setting in which lesson study is implemented in Zambia.

Dependability

The debriefings with my research supervisors were necessary to ensure the dependability of this research. The role that supervisors play in promoting research dependability cannot be over-emphasised (Sikolia, Biros, Mason & Weiser, 2013). Further, the processes used in this research are reported in detail to motivate other researchers to conduct similar studies.

Confirmability

Confirmability helps assure that the data, interpretations, and findings are grounded in the context from which they came (Houghton, Casey, Shaw & Murphy, 2013; Lincoln & Guba, 1985). Therefore, steps were taken to help ensure as far as possible that the findings of the research are the result of the experiences and ideas of the participants in this research, rather than the characteristics and preferences of the researcher.

Triangulation was used in data collection. Data triangulation implies the collection of
accounts from different participants in a prescribed setting, from different stages in the activities of the setting and, if appropriate, from different sites of the setting (Banister et al., cited in Holtzhausen, 2001). It also entails cross-checking of the consistency of specific and factual data items from various sources via multiple methods at different times (Guba & Lincoln, 1989). In this study, data triangulation involved the comparison of the data from documents on lesson study with the interview and video data, and Grade 12 mathematics examination results. However, this triangulation may not guarantee a single, accurate, and consistent picture, but rather presents a challenge to improve understanding of the various reasons for the existence of contradictions between the data from documents on lesson study, interview and video data, and Grade 12 mathematics examination results.

Furthermore, beliefs underpinning decisions made and methodologies and methods adopted have been acknowledged in this thesis. Also, the reasons for favouring one approach over others are explained, and the weaknesses in the techniques used are admitted. Furthermore, a reflexive diary was kept for logging important activities, schedules, and dates that otherwise might have been forgotten with time. All video and audio recordings, transcripts, field notes, and descriptions are stored as required by Deakin University.

3.3.5 Research ethics

The Australian National Statement on Ethical Conduct in Human Research states that

All human interaction, including the interaction involved in human research, has ethical dimensions. However, ethical conduct is more than simply doing the right thing. It involves acting in the right spirit, out of an abiding respect and concern for one’s fellow creatures. (Australian Government, 2007a, p. 3)

Deakin University states that all research with human participants or their data requires ethics approval. This research involved interacting with people involved in the implementation of lesson study in mathematics in Zambia, and therefore, required adherence to ethical requirements. Deakin University’s Human Research Ethics Committee (DUHREC) approved this study.
Chapter 4 Lesson study in Zambia

This chapter addresses the subsidiary research question SQ1: How is Lesson study in mathematics defined by the Zambian Ministry of Education and interpreted by in-service providers, school administrators, and teachers of mathematics?

The Zambian Ministry of Education, as in other countries, has defined lesson study for use in Zambia. As with many adoptions, there are differences from the original Japanese Study model. This chapter uses the Onion Rings Model, shown in Figure 3.1, to compare the Zambian definition of lesson study with the Japanese model, and compare its interpretation by in-service providers, school administrators, and mathematics teachers with the Zambian model and between the rings.

In this chapter, the School environment refers to the views of the school administrators who took part in the interviews. Other aspects of the school environment will be discussed in Chapter 6.

4.1 The Ministry of Education’s definition of lesson study in Zambia

This section presents the Ministry’s definition of lesson study for use in Zambia based on key Ministry publications related to lesson study. This definition is compared and contrasted with the Japanese Lesson Study model.

4.1.1 Key publications

Three Ministry documents were analysed to establish how lesson study in mathematics has been defined for use in Zambia. The context of each of these documents is given below.

School-Based CPD through lesson study/Teaching Skills Book (MOE & JICA, 2009) – hereafter referred to as the Teaching Skills Book.

The Ministry of Education (MOE) and the Japanese International Cooperation Agency (JICA) produced the Teaching Skills Book based on the lesson study experiences from the

In 2005, the project targeted 425 Grades 8–12 science teachers in 200 upper basic (Grades 8–9) and high schools (Grades 10–12) in Central Province. By 2007, nearly 2000 teachers in Grades 8–12 in the three provinces practised lesson study in all subjects (MOE, 2007). Based on the experiences from the three provinces, the Teaching Skills Book “aimed at not only providing appropriate teaching skills but also to deepen the teachers’ knowledge and skills” (MOE & JICA, 2009, p. iii). It was “designed to benefit the key stakeholders such as teachers, [lesson study] facilitators and others who implement school-based programmes” (MOE & JICA, 2009, p. iii). The Ministry perspective on lesson study contained in the Teaching Skills Book is summarised later in this chapter.

School-Based Continuing Professional Development Implementation Guidelines (MOE & JICA, 2010b) – hereafter referred to as the Implementation Guidelines.

As was the case with the Teaching Skills Book, MOE and JICA developed the Implementation Guidelines based on experiences from lesson study activities under the SMASTE-SBCPD Project in Central, Copperbelt and Northwestern Provinces. These guidelines were developed for “Teachers, Senior teachers, Deputy Headteachers, Headteachers, Facilitators and all Stakeholders at various levels of the education system to use for effective implementation and management of the school-based CPD through lesson study” (MOE & JICA, 2010b, p iii).

The master plan for strategic expansion and implementation of school-based CPD programme 2010-2023 (MOE, 2010) – hereafter referred to as the Master Plan.

MOE developed the Master Plan for rolling out the SMASTE-SBCPD Project, which had been pilotted in the three pilot provinces, to the remaining six provinces of Zambia. In 2011, a new province, Muchinga Province, was created in Zambia, requiring MOE to roll out lesson study to seven provinces. The Master Plan highlighted the key strategies that would be used to expand the project using the experiences gained in the pilot provinces (MOE, 2010). As can be
seen in Figure 4.1, the Master Plan described four stages for the expansion of school-based continuing professional development (CPD).

- Stage II (2009 – 2012): Upgrading of content and skills through the development of the teaching skills book and the management skills book in consultation with NISTCOL [National In-Service Teachers’ College]
- Stage IV (2018 – 2023): Application of skills books in schools, districts and by teachers

Figure 4.1. The four stages of SBCPD expansion (Source: MOE, 2010)

According to MOE (2010), rolling out the lesson study project to the remaining seven provinces required the establishment of a lesson study model for Zambia, and the application of the Implementation Guidelines, the Teaching Skills Book, and the Management Skills Book. As indicated in Figure 4.1, MOE consulted the National In-Service Teachers’ College (NISTCOL) when developing the Teaching Skills Book and the Management Skills Book. Opened in 1970, NISTCOL offers in-service training for teachers in basic and high schools (mainly through delivering a primary teachers’ diploma by distance learning); educational leadership and management for head teachers; and school guidance and counselling (Junaid & Maka, 2015).

The Zambian model of lesson study

The Master Plan stated that the lesson study model for Zambia is based on Japanese Lesson Study and the Philippines School Training Programme (SBTP). According to MOE (2010), the Japanese Lesson Study model was modified to suit the Zambian school context. However, contextualizing lesson study in Zambia was not a one-off activity. For example, Jung, Kwauk, Nuran, Robinson, Schouten, and Tanjeb (2016) stated that lesson study in Zambia was continuously refined to suit the Zambian context.
The Zambian lesson study cycle

A major issue related to the Zambian context that led to the modification of the lesson study cycle was that many schools had a large number of unqualified mathematics and science teachers. According to the Implementation Guidelines, conducting lesson study meetings across school departments, or in clusters, could benefit many schools with limited qualified science or mathematics teachers (MOE & JICA, 2010b). In this vein, MOE considered that a lesson study cycle should comprise many steps to help develop these unqualified teachers. As a result, four steps were added to the Japanese Lesson Study cycle, with the Zambian model of lesson study having the eight steps shown in Figure 4.2.

![Figure 4.2. The Zambian lesson study cycle (Source: MOE & JICA, 2010b, p. 8)](image)

By way of contrast, the Japanese Lesson Study cycle, according to Lewis (2002), ends at Step 4. It should also be noted that the Zambian model of lesson study describes the research lesson of the Japanese model as a demonstration lesson or Demo-Lesson, as can be seen in Step 3 of Figure 4.2.

According to Jung et al. (2016), Steps 5 to 8 were necessary for Zambia because knowledge and content gaps continued to be a challenge for mathematics and science teachers throughout Zambia, and teachers often faced great difficulty creating effective lessons in these subjects.
Four additional steps were added to the lesson study cycle to ensure that teachers had the opportunity to continue to share and practice among each other, building their confidence in delivery while helping them and their peers to master the content. (Jung et al., 2016, p. 7)

Similarly, the *Implementation Guidelines* stated:

This model is an appropriate approach for building the capacity of teachers teaching mathematics and science in upper basic and high schools who do not have the minimum stipulated qualifications to teach at these levels. (MOE & JICA, 2010b, p. 10)

The *Implementations Guidelines* characterised each step of the cycle, as follows:

1. **Defining the problem or challenge (1-2 hours)**: Discuss problems/concerns and challenges teachers face (such as questioning techniques, difficult topics, and pedagogical approaches). Discover the difficult topic to teach, the problem in teaching such a topic, the methods the teachers want to learn and suggested solution made by the teachers.

2. **Collaboratively planning the lesson (2-3 hours)**: Demonstration teacher prepares an initial lesson plan prior to the meeting. The lesson study group considers the initial lesson plan and give suggestions for improvement. Demonstration teacher finalises the lesson plan. The lesson study group defines points of observation and allocate observation tasks to each teacher (such as lesson introduction, objectives, and use of teaching materials).

3. **Implementing demonstration-lesson (1 to 2 periods)**: One team member implements the lesson in a classroom while other teachers observe and evaluate the lesson. Each focuses on the assigned point of observation (such as introduction, questioning of the teacher, lesson evaluation, conclusion, and classroom

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1 The *Implementation Guidelines* specified that the number of teachers in a lesson study group should range from 3 to 15. Schools that only had few teachers in certain subjects, were expected to use a cluster or zone approach to have their lesson study meetings.

2 One class period lasts 40 minutes.
management). Record observations.

4. **Discuss the lesson and reflect on its effects (1-2 hours):** Hold a formal meeting immediately after the lesson. Ask demonstration teacher’s impression of the lesson first. Critique the lesson based on the observations. Centre the critique on the lesson and not on the demonstration teacher.

5. **Revise the lesson (1-2 hours):** Demonstration teacher, or group of teachers, revise the lesson plan based on the suggestions and comments given in the discussion;

6. **Teach the revised lesson (1 to 2 periods):** Conduct revised lesson at the same grade level, but in a different class. Split the class if there is only one so that the demonstration lesson is taught to half class and the revised to the other half. Observe the revised lesson with special attention on the points for improvement. Record the observations.

7. **Discuss the lesson and reflect on its effect again (1-2 hrs):** Hold a second post-demonstration meeting with all teachers who observed the lesson to discuss if it has been improved and to define what the teacher has learned during the lesson study cycle. Record the discussion and file it as a school-CPD report.

8. **Reflections compiled and shared (every school term):** Head of Department/Head of Section and Headteachers/Deputy Headteachers prepare a report on school-based lesson study and submit it to the district office. This report should be reflected in the School In-service Record (SIR) book. The District Education Support Team (DEST) summarise the contents of the reports and share with other schools in the next Stakeholders’ Workshop. Outstanding practices in lesson study are shared at provincial, national, and international conferences. (MOE & JICA, 2010b, pp. 20-22)

According to the **Implementation Guidelines**, the schools implementing lesson study should adhere to this eight-step lesson study cycle.

**Frequency of lesson study cycles**

According to the **Implementation Guidelines**, lesson study had to happen in every subject area every month:
[The Ministry] has taken lesson study as an important intervention which has added value and fitted into the SPRINT system of in-service. It is for this reason that [the Ministry] has found it necessary to extend lesson study to all the subjects and all grades. This is currently being implemented in Central, Copperbelt and North Western Provinces before rolling out to the rest of the country. (MOE& JICA, 2010b, p. 5)

**Duration of a lesson study cycle**

According to the *Implementation Guidelines*, a lesson study cycle should be completed within five days, stating that “The duration between the time of preparations, first demo, second demo and the final preparations should be within five days at the most” (MOE & JICA, 2010b, p. 19).

The *Implementation Guidelines* further specified that lesson planning, revision of the taught lesson, and post-lesson discussion, should be held “during the school day, outside teaching time, while lesson demonstrations should be conducted during lesson time so that the developed lessons are tried in an actual class” (MOE & JICA, 2010b, p. 18).

However, Murata and Takahashi (2002) state that the typical duration of a single lesson study cycle in a Japanese elementary school is more than five weeks. According to Fujii (2014, p. 3), “it sometimes takes more than half a year to design a task and plan a lesson”. This supports the statement by Ebaeguin and Stephens (2014) that the research and planning phase of lesson study is thorough and time-consuming.

**Setting goals for lesson study**

Although the eight-step lesson study cycle shown in Figure 4.3 did not state that teachers should set long-term goals for the learner, the *Teaching Skills Book* states that teachers should “align their lessons with the goals of the Ministry of Education” (MOE & JICA, 2009, p. viii) and further, that the mandate of the education system, and a teacher in particular, is to come up with strategies they could use to develop lessons that would achieve this mission. Therefore, teachers should base their lessons on the goals of the Ministry.

Although teachers should embrace the Ministry’s long-term goals for students when developing their lessons, they should also develop short-term goals or lesson objectives. The
Teaching Skills Book, for example, states that teachers should develop sound lesson objectives as

    The success of the lesson is dependent on the objectives set in a lesson. It is very important for us to check how the objectives have been written and if at all they were attained in the lesson delivery. (MOE & JICA, 2009, p. 31).

    According to the Teaching Skills Book, these lesson objectives “should also be written in a behavioural way so that teachers and students are able to find if they had been attained in a lesson” (MOE & JICA, 2009, p. 11).

Investigation of instructional materials

    The documents specified that investigation of teaching materials is key to lesson success. The Teaching Skills Book, for instance, stated that:

    Teachers need to plan carefully for each lesson – taking into account how students learn, the requirements of the curriculum, the most appropriate method of teaching the topic and the resources available, as well as the evaluations of previous lessons. (MOE & JICA, 2009, p. 10)

    According to the Implementation Guidelines, teachers would often start planning the lesson by looking at the available resources such as reference books and articles produced by other teachers. This emphasis on investigating a wide range of instructional materials is similar to Japanese kyozaikenkyu – a rigorous and intricate investigation of a range of instructional materials, including textbooks, curriculum materials, lesson plans and reports from other lesson studies, coupled with a study of students’ prior understandings (Watanabe, Takahashi & Yoshida, 2008). The importance of deep kyozaikenkyu is that it helps teachers to gain knowledge and insight into mathematics and student thinking (Takahashi, Watanabe, Yoshida, & Wang-Iverson, 2005; Lewis, Perry & Friedkin, 2011).

The lesson plan

    In the Teaching Skills Book, a lesson plan is defined as “a detailed step-by-step description of how the lesson will progress in order to achieve the lesson objectives” (MOE & JICA, 2009, p. 10). A typical template for a lesson plan contains the title of the lesson; the name
of the teacher; the name of the school; the grade; the date and time of the lesson; the lesson
duration; the class used for the demonstration lesson; the topic and sub-topic; lesson rationale;
lesson objectives; pivotal questions the teachers should ask students; students’ pre-requisite
knowledge and skills; resources and materials; references; the lesson process (usually shown as
a table); the method for assessment; and remarks.

Lesson rationale

The *Teaching Skills Book* described the lesson rationale as a general statement
justifying the significance of the lesson. The rationale should emphasise the relevance and
usefulness of the content of the lesson to the learner broadly, thereby affording the teacher an
opportunity to see why the lesson needs to be taught. In addition, it should show how the teacher
understands the knowledge and skills to be taught in the lesson (MOE & JICA, 2009).

The *Teaching Skills Book* outlined four components of the rationale, which should be
addressed when planning the research lesson.

- **content**: an outline of what is to be taught and learned in a lesson;
- **concept/value**: an outline of why the lesson should be learned (e.g., the direct
  relevance of the lesson to students’ daily life or the misconceptions the lesson
  intended to correct);
- **methods**: approaches that the teacher could use to deliver the lesson, and how
  the lesson objectives could be attained with the chosen approaches; and
- **location of the period**: the location of the planned lesson in the total planned
  periods for teaching a particular unit (MOE & JICA, 2009, p. 11).
In Figure 4.3, part 1) of the rationale is about the content, stating what was to be learned (i.e., the meaning of electrical ratings labelled on electrical appliances). Part 2) is about the value of the lesson to students – helping them to conserve power by using the appliances correctly. Part 3) is about the methods for delivering the lesson. Part 4) is the location of the period and the total number of lessons for each topic or unit as stated in the syllabus.

Lesson objectives

The Teaching Skills Book defined lesson objectives as “specific statements which set out what students are expected to learn from a particular lesson in a way that allows the teacher to identify if learning has occurred” (p. 11). It is also stated that lesson objectives should be written in a behavioural way so that teachers and students can establish whether lesson objectives have been achieved.

The four key points for writing behavioural objectives were stated as:

- **Audience:** For whom the objective is intended – should be learners.
- **Behaviour:** The expected student behaviour (overt or covert) as a result of the lesson.
• **Conditions:** Situations you will impose when children are demonstrating their mastery of the objectives.

• **Degree of Proficiency:** Acceptable level of performance for the objective (MOE & JICA, 2009, p. 12).

Pre-requisite skills and knowledge

This component, according to the *Teaching Skills Book* outlines the concepts that students need to master in advance to accomplish the lesson objectives. They could be drawn from the objectives of previous lessons.

Pivotal questions

The *Teaching Skills Book* explained the role of the teacher as follows:

> The role of the teacher is to help the learner to learn and, therefore, he or she should create situations where learners investigate what is to be learned as a problem to solve by posing and answering questions, discussing and sharing insights, trying out ideas, using concrete models and so on. (MOE & JICA, 2009, p. 13)

To create such situations, the teacher should ask students a pivotal question because “a pivotal question enables students to have prediction and discussion before an activity. It introduces, motivates students’ discussion or discoveries and clarifies major ideas” (MOE & JICA, 2009, p. 13). The *Teaching Skills Book* stated that pivotal questions should be related to the objectives of the lesson; written in advance in a lesson plan; and followed by several emerging questions in the lesson as well.

Lesson introduction

The *Teaching Skills Book* stated that, when introducing the lesson, it was “important to think how you are going to tie the lesson objectives with learners’ interests and past classroom activities” (MOE & JICA, 2009, pp. 15-16). Therefore, the introduction might comprise an activity aimed at re-examining previous knowledge and providing an informal experience with, and stimulating interest in, new learning. Also, the lesson introduction should offer a break between activities that had just been completed (for example, a prior class) and the activities that were about to take place. Figure 4.4 shows an example of a lesson introduction.
It is clear from Figure 4.4 that the lesson introduction focuses on the revision of what students already know. A learning point refers to what students learn after completing the task or answering the question. For example, students would learn about the ammeter after addressing question 1 in Figure 4.4.

Lesson development

The *Teaching Skills Book* defined the lesson development as “a coherent collection of several activities, where each activity develops what is to be learned in a different way” (MOE & JICA, 2009, p. 16). The lesson development aims to develop what is to be learned in depth. However, teachers were challenged to consider the following five essential characteristics of lesson development.

- A single clear focus – the lesson should focus clearly on the outcome and only involve other matters that have direct relevance to that outcome.
- Supporting a problem-solving climate of learning.
- Reasonably answering the question of “Why are we learning this?”
- Providing multiple learning contexts – several different activities should be used to develop the outcome.
- Assessing teaching. (MOE & JICA, 2009, p.16)

Lesson conclusion

According to the *Teaching Skills Book*, the lesson should close with a plenary session in which the teacher draws out key points. During the conclusion, learning should be reviewed, and there should be an opportunity to reflect on the learning process. Students do most of the
talking, as they are encouraged to explain what they have learned and how it could be used in the future, perhaps in other lessons (MOE & JICA, 2009). Figure 4.5 shows the activities planned for the lesson conclusion for the sample lesson plan in the *Implementation Guidelines*.

<table>
<thead>
<tr>
<th>CONCLUSION (15 min.)</th>
<th>Pupils are asked to have exercise.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. What is the unit of power?</td>
</tr>
<tr>
<td></td>
<td>2. A current of 6A flows through a bulb connected to a 240V supply. Calculate its power.</td>
</tr>
<tr>
<td></td>
<td>3. An electric motor is rated 36W, 12V. What current does the appliance use?</td>
</tr>
<tr>
<td></td>
<td>4. Write the reason why it is not recommended for us to use appliances with big power in the same time?</td>
</tr>
<tr>
<td></td>
<td>- Watt.</td>
</tr>
<tr>
<td></td>
<td>- $P=1440$ watts</td>
</tr>
<tr>
<td></td>
<td>- $I=3A$</td>
</tr>
<tr>
<td></td>
<td>Because it causes big current which break the circuit in the house.</td>
</tr>
</tbody>
</table>

Figure 4.5. An example of a planned lesson conclusion (Source: MOE & JICA, 2010b, p. 79)

The exercise shown in Figure 4.5 contradicts the earlier statement in the *Implementation Guidelines* that during the lesson conclusion students do most of the talking, as they are encouraged to explain what they have learned and how it could be used in the future, perhaps in other lessons. With such an example, it is possible that the planning groups using the sample lesson in the *Implementation Guidelines* would give students an exercise as the conclusion.

**Lesson evaluation**

This stage focusses on whether the lesson objective was achieved. The lesson objectives could be evaluated by collecting and assessing students’ work, asking questions and listening to their answers. Also, students could give comments on the entire lesson. For example, they could comment on time, difficulties, achievement of lesson objectives, and areas that need improvement (MOE & JICA, 2009). Figure 4.6 shows examples of three areas an evaluation of the sample lesson could address.

<table>
<thead>
<tr>
<th>Evaluation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Were the pupils able to give samples of electric appliances?</td>
</tr>
<tr>
<td>2) Were the pupils able to identify the ratings labelled on the appliances?</td>
</tr>
<tr>
<td>3) Were the pupils able to find the process of calculating electric current using the ratings on the appliances and get correct answers?</td>
</tr>
</tbody>
</table>

Figure 4.6. Sample evaluation criteria (Source: MOE & JICA, 2010b, p. 79)
The three questions in Figure 4.6 were directly translated from the three lesson objectives shown in Figure 4.7.

<table>
<thead>
<tr>
<th>OBJECTIVES: By the end of the lesson PSBAT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Give examples of electrical appliances</td>
</tr>
<tr>
<td>ii) Identify the ratings labelled on each electrical appliance</td>
</tr>
<tr>
<td>iii) Calculate current used by each electrical appliance in reference to the ratings labelled on it.</td>
</tr>
</tbody>
</table>

Note: PSBAT stands for Students Should Be Able To

Figure 4.7. Sample lesson objectives (Source: MOE & JICA, 2010b, p. 78)

In the Japanese Lesson Study context, Lewis (2002, pp. 127–130) noted that a typical research lesson plan comprised the name of the unit; unit objectives; the research theme; current characteristics of students; a plan for the unit; a plan for the research lesson; and background information and data collection forms for observers (e.g. a seating chart). The plan for the unit includes connections to the syllabus and to prior and subsequent learning, the sequence of lessons in the unit and the tasks for each lesson, and an explanation of unit flow.

While similarities between the Zambian and Japanese lesson plan templates exist, there are differences also. First, the Japanese template includes the “research theme” which, in the context of Japanese Lesson Study, Fujii (2016, p. 3) states “is developed through consideration of the reality of students’ current state vis-à-vis educational or long-term goals for their learning and development”. However, in the Zambian adaptation, there is no mention of a research theme.

Another difference is that the lesson plan appended in the Implementation Guidelines has three pages, while according to Takahashi and McDougal (2016, p. 520), “a thorough lesson research proposal may be 9 pages”.

Anticipating student solutions is also not emphasised in the Zambian policy documents, whereas in Japan anticipating student solutions at planning meetings is important and is a critical feature in task design (Fujii, 2015).
Approaches used in lesson delivery

In Zambia, the *Teaching Skills Book* acknowledged that there are many approaches used in lesson delivery around the world. It identified the following four approaches that could make the classroom setting an opportunity for active learning.

(i) **Mastery Learning Approach:** According to Block and Anderson (1975) and Bloom (1976), the principal defining characteristics of a mastery learning approach are: the setting of a criterion performance level, considered to represent mastery of a given skill or concept; the frequent assessment of student progress toward the mastery criterion; and “provision of corrective instruction to enable students who do not initially meet the mastery criterion to do so on later parallel assessments” (Slavin, 1987, p 175). The *Teaching Skills Book* stated that this approach allowed students to explain what they have understood so that an assessment could be made as to whether or not they had mastered the topic.

(ii) **Inquiry-Discovery Approach:** According to the *Teaching Skills Book*, this approach motivated students by letting them discover new concepts through discussion or activity.

(iii) **ASEI/PDSI Approach:** In this approach, ASEI stands for “Activity, Student-Centred Experiment and Improvisation” and PDSI for “Plan Do See and Improve”. The *Teaching Skills Book* stated that in the ASEI/PDSI Approach, students experience a series of practical activities. The teacher takes the role of a facilitator.

(iv) **Problem-Solving Approach:** The *Teaching Skills Book* stated that the Problem-Solving Approach required: giving the main problem to students and letting them find a solution; letting students interact with the teacher and among themselves; and letting them discuss and draw conclusions from their findings. The teacher takes the role of a facilitator. (MOE & JICA, 2009, pp. 14-15)

The *Teaching Skills Book* stated that teachers should mix the four approaches, depending on the difficulty of lesson content, level and interest of students, and availability of learning materials. A justification for mixing the four approaches was that:
It is considered that learner-centred lesson requires teachers to use a variety of approaches to realize active learning of students. (MOE & JICA, 2009, p. 13)

In contrast, as described in Chapter 2, Japanese Lesson Study in mathematics typically uses structured problem-solving lessons. Shimizu (1999), for example, stated that a typical Japanese research lesson in mathematics consisted of posing the problem, students working individually or in groups, whole-class discussion of student solutions, and highlighting and summarising main points.

**Observing the lesson**

According to the *Implementation Guidelines*, while one team member teaches the lesson in a classroom, others observe and evaluate the lesson. Each observer should focus on assigned points of observation, such as the lesson introduction, the teacher’s questioning, lesson evaluation, the conclusion, and classroom management.

In the Japanese model, the main goals of observing a research lesson are to understand student thinking and learning processes, collect data to support inferences, and establish how students received the lesson, so the observers understand what the planning team intended to teach (Takahashi & Yoshida, 2004). Takahashi and McDougal (2016) also stated that observers are responsible for collecting data on how the lesson affects the students, relative to the research theme and the learning goals. Therefore, lesson observation focusses on teaching and learning processes. According to Lewis and Tsuchida (1998), focussing on how students responded to the lesson helps the planning team to gain insights into the teaching and learning processes.

The *Implementation Guidelines* state that observers should focus on teaching and not the teacher, and provides checklists for lesson observation. However, according to Fujii (2014), the checklists used at research lessons in Uganda focussed on the teacher and not teaching. He stated that the use of a checklist is not wrong, depending on the context, giving an example that school principals in Japan also used a checklist in evaluating teachers for purposes other than teaching. However, he argued that the purpose of checklists in lesson study needs to be reconsidered.

The *Teaching Skills Book* also stated that a lesson plan should be used when observing the lesson.
The lesson plan shows the ability of a teacher. The advice to be offered and the skills of a teacher and dependant [sic] on the lesson plan. It is important to have a lesson [plan] in order to complete the evaluation. (MOE & JICA, 2009, p. 33)

In Japan, lesson plans are also part of the research lesson observation (see, for example, Doig & Groves 2011; Fujii, 2014), with Doig and Groves stating that “all observers are provided with a copy of the detailed lesson plan” (p 84). According to Fujii, one of the functions of the lesson plan is to shift the focus from teachers to teaching during lesson observation and post-lesson discussion, with the lesson plan becoming an effective tool when observers study it before observing the research lesson study. Wake, Foster and Swan (2013) regard the lesson plan as being at the nexus of understanding of teaching and learning intentions.

In the classroom, it acts as a mediating instrument as a script by which the teacher organizes the research lesson, but it has other roles to play beyond this at different times in the activity of the lesson study group. (Wake et al., 2013, p. 372)

**Participation of external experts in lesson study**

An external expert, or *knowledgeable other*, “is someone from outside of the planning team with deep expertise in the content, often deep expertise in teaching, and much experience with lesson study” (Takahashi & McDougal, 2016, p. 515). According to the *Implementation Guidelines*, external experts include education standards officers, lecturers from colleges of education and universities, and lesson study facilitators. The role of a lesson study facilitator in Zambian lesson study goes beyond observing the demonstration lesson. According to the *Implementation Guidelines*, a facilitator should participate in lesson planning, check the lesson plan before the lesson is conducted, observe the demonstration lesson, facilitate discussions after the lesson, and prepare and submit the facilitation report (MOE & JICA, 2010b, p. 24).

As stated in Chapter 2, a number of researchers have indicated the significance of outside expertise provided by a knowledgeable other in making lesson study effective (e.g., Takahashi, 2011; Takahashi & Yoshida, 2004). Takahashi (2014) and Fujii (2016) stated that Japanese schools invite a knowledgeable other to their research lessons and ask the person to provide final comments. According to Fernandez, Yoshida, Chokshi, and Cannon (2001), a knowledgeable other participates in the lesson study to provide a different perspective on the work of the lesson study group, to provide information about the subject matter content, new
ideas, or reforms, and to share the work of other lesson study groups (p. 18). A case study of three experienced knowledgeable others in Japan by Takahashi (2014) revealed ways in which their final comments helped participants connect the lesson with broad issues in mathematics and pedagogy.

**Sharing lesson study results**

Sharing lesson study results is the main aim of Step 8 in Figure 4.3. The *Implementation Guidelines* stated:

After reflections are compiled and shared, a report is forwarded to other relevant officers to enable them to avail it to other stakeholders so that the experiences could further be shared at fora such as Departmental/Section meetings, stakeholder workshops, Subject Association meetings, Education Conferences etc. Further development of such materials could be documented and published in journals or newsletters as alternatives, which have been trialled. (MOE & JICA, 2010, p. 10)

According to this, heads of departments or sections, and head teachers or deputy head teachers are supposed to prepare a report on lesson study and submit it to the district office. The District Education Support Team (DEST) should summarise the content of lesson study reports from schools in the district and share the findings at the next Stakeholders’ Workshop. Furthermore, outstanding practices in lesson study are to be shared at provincial, national, and international conferences.

Regarding sharing lesson study results in Japan, Fujii (2014, p. 4) stated that “Each research lesson and its post-lesson discussion occupy only one day, but the teachers reflect on what they learned at the research lessons and usually write a booklet or long summary report by the end of the school year”.

### 4.2 Zambian lesson study versus Japanese Lesson Study

Table 4.1 compares the information from the Ministry documents regarding lesson study in Zambia with the Japanese Lesson Study model.
Table 4.1  A comparison of the Ministry of Education’s definition of lesson study in Zambia with Japanese Lesson Study

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Japanese Lesson Study</th>
<th>Zambian model of lesson study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps in the lesson study cycle</td>
<td>• Four steps</td>
<td>• Eight steps including reteaching the research lesson</td>
</tr>
<tr>
<td>Duration of a lesson study cycle</td>
<td>• More than five weeks</td>
<td>• Five days at the most</td>
</tr>
<tr>
<td>Setting goals for lesson study</td>
<td>• In a school-based lesson study, align research goals with those of the school</td>
<td>• Align goals with those of the Ministry of Education</td>
</tr>
<tr>
<td></td>
<td>• Embedding research lesson in curriculum</td>
<td>• Rationale focussed on content, value, methods and location of lesson in unit</td>
</tr>
<tr>
<td></td>
<td>• Long-term goals</td>
<td>• Lesson objectives should be written in a behavioural way</td>
</tr>
<tr>
<td>Investigating instructional materials</td>
<td>• Rigorous investigation of a range of instructional materials (kyozaikenkyu)</td>
<td>• Plan carefully for each lesson</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Plan by looking at the available resources</td>
</tr>
<tr>
<td>Lesson plan</td>
<td>• A typical template for a lesson plan contains 5 items.</td>
<td>• A template for a lesson plan contains 16 items</td>
</tr>
<tr>
<td></td>
<td>• Maybe 9 pages</td>
<td>• Sample lesson plan appended in the Implementation Guidelines had 3 pages</td>
</tr>
<tr>
<td>Approaches used for delivering research lesson</td>
<td>• Research lessons in mathematics typically use structured problem solving</td>
<td>• Teachers should mix four approaches</td>
</tr>
<tr>
<td>Observing the research lesson</td>
<td>• Observers collect data on how the lesson affects students</td>
<td>• Members of the planning team observe and evaluate the lesson.</td>
</tr>
<tr>
<td></td>
<td>• Lesson observation focusses on teaching and learning processes.</td>
<td>• Each observer should focus on assigned points</td>
</tr>
<tr>
<td></td>
<td>• Focus on how students responded to the lesson</td>
<td>• Focus is on students not teacher</td>
</tr>
<tr>
<td>Participation of a knowledgeable other</td>
<td>• Schools invite a <em>knowledgeable other</em></td>
<td>• External experts include Ministry of Education officers.</td>
</tr>
<tr>
<td></td>
<td>• Final comments are given by the knowledgeable other</td>
<td>• No suggestion that experts provide final comments</td>
</tr>
<tr>
<td>Sharing lesson study results</td>
<td>• Teachers write a booklet or long summary report by the end of the school year</td>
<td>• Lesson study reflections are compiled and shared</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• DEST summarises the reports from schools and shares at the next Stakeholders’ Workshop.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Outstanding practices in lesson study are shared widely</td>
</tr>
</tbody>
</table>
In Zambia, an overriding goal of lesson study is to transform teacher-centred lessons to student-centred lessons. To do so, the Ministry expects lesson study groups to align their research lesson objectives with the goals of the Zambian education system.

The value that the *Teaching Skills Book* places on the investigation of a wide range of instructional material when planning a research lesson is similar to the practice in Japan. Taking into account how students learn, the curriculum requirements, the most appropriate teaching methods, the resources available, and the evaluations of previous lessons is essential to deriving an effective lesson plan in Zambia. Similarly, in Japan, the successful implementation of lesson study depends on *kyozaikenkyu* – an intensive study of a range of instructional materials, including textbooks, curriculum materials, reports and lesson plans from other lesson studies, together with a study of students’ prior understandings.

In the Zambian model, however, the challenges stated in the *Teaching Skills Book* regarding research lesson planning might result in the study of teaching materials that is neither profound nor broad. These challenges are inadequate syllabi in some schools, inadequate planning skills of teachers, lack of time to write lesson plans, difficulties related to writing the lesson rationale, and difficulties in instituting a student-centred lesson (MOE & JICA, 2009).

According to the *Teaching Skills Book*, there was a lack of time to write research lesson plans, as most school departments, especially the science and mathematics departments, were understaffed and so the few teachers available are overloaded.

The *Teaching Skills Book* stated that teachers should share the points of observation to make sure that all the important aspects of the lesson are observed. Similarly, in Japan, teachers pay careful attention to what they look for in their lesson observation.

In Japan, teachers typically use the structured problem-solving approach to teach mathematics research lessons. In Zambia, however, the *Teaching Skills Book* stated that teachers should mix four teaching approaches – Mastery Learning Approach, Inquiry-Discovery Approach, ASEI/PDSI Approach and Problem-Solving Approach – when delivering the lessons.

In Zambia, the *Implementation Guidelines* stated that teachers should invite experts from various educational institutions occasionally as observers at lesson study sessions. In Japan, however, inviting an external expert (an advisor or knowledgeable other) to attend and comment on the lesson study is the usual practice.
In Zambia, pre-requisite skills and knowledge refers to the concepts that students need to master in advance to accomplish the lesson objectives, and these could be drawn from the objectives of previous lessons. In a similar sense, Japanese Lesson Study involves teachers taking into consideration the current knowledge of students when planning the research lesson.

The *Teaching Skills Book* stated that introducing a pivotal question motivated student discussion or discoveries and clarified major ideas. In Japan, a mathematics lesson is typically designed around solving a single problem to achieve a single objective on a topic.

The *Implementation Guidelines* stated that teachers should suggest the solutions to the challenging topics they intended to teach. Whereas Japanese teachers anticipate students’ solutions and misconceptions in a given task, the *Implementation Guidelines* was not explicit about teachers identifying student misconceptions.

### 4.3 In-service providers’ interpretation of lesson study

Interviews were conducted with two Ministry of Education Officers (MOE1 and MOE2) and six other in-service providers (ISP1-ISP6). This section is based on data from these interviews.

#### 4.3.1 In-service providers’ interview responses

This section focusses on the responses of these participants in terms of their understanding of lesson study, the sources of information on lesson study, how lesson study differs from other CPD approaches, what teachers learnt by participating in lesson study, and any concerns they had about teachers participating in lesson study.

**Understanding of lesson study**

Two in-service providers (ISP3 and ISP4) stated that the Ministry had defined the Zambian lesson study model as comprising eight steps. According to ISP3, the major activities for teachers in the eight steps were to “plan the lesson, try out, re-plan, perfect it [the lesson plan] and go and deliver it to students”. ISP4 commented that the eight-step lesson study model helped teachers to:
Study together, brainstorm together, then develop a lesson plan, and then come up with the teaching strategy to use. Maybe one or two methods that are going to be used in the process of tackling that so-called difficult area. That is how it is done. (ISP4)

According to ISP3 and ISP4, lesson study involved “perfecting the lesson plan”. When asked to give reasons, ISP3 stated that revising and re-teaching implied that lesson study helped perfect the lesson plan. By way of contrast, the purpose of lesson study in Japan is not targeted at refining a lesson plan but to gain new knowledge for teaching and learning (Takahashi & McDougal, 2016). As observed by Fujii (2014), re-teaching a research lesson even once is not common practice in Japan.

According to MOE2 and ISP5, lesson study was a problem-solving strategy that helped to build the capacity of teachers in delivering student-centred lessons. MOE2 said that teachers’ pedagogical strategies would be enhanced through lesson study, while ISP5 added that this, in turn, would affect student achievement. ISP5’s response to a follow-up question on what he meant by “problem-solving strategy” was that lesson study started with giving students a problem to solve instead of telling them strategies to find a solution. This idea of using a problem-solving strategy, as stated by ISP5, is similar to the approach widely used in Japanese lessons of “teaching mathematics through problem-solving” (Shimizu, 2003). Shimizu’s (1999) four stages of a Japanese structured problem-solving lesson have been stated in Chapter 2. However, ISP5 did not state whether the problem-solving strategy was similar to that as stated by Shimizu.

Duration of a lesson study cycle

According to MOE1, a lesson study cycle in Zambian schools should be completed within a month. He stated that

One lesson study cycle takes a month to complete. So, there is a space of four days in between each activity. When teachers meet to plan a lesson to discuss the challenges, when they agree on one challenge, there is a space of four days. First of all, they go to their classes, and they continue teaching. After four days, they would meet again now to plan a lesson together to address that particular challenge. After
planning again, there is a space of four days. So a cycle, lesson study cycle, is completed in about a space of one month. (MOE1)

This contrasts with the Implementation Guidelines where it is specified that teachers should complete a lesson study cycle within five days (MOE & JICA, 2010).

**Setting goals for lesson study**

According to ISP4, lesson study involved the identification of a challenging topic or problem. This resonated with the statement in the Implementation Guidelines that lesson study involved teachers of the same subject or grade meeting to discuss problems and challenges in teaching, including questioning techniques, difficult topics, and pedagogical approaches (MOE & JICA, 2010B). This practice is also similar to the Japanese model, in which, according to Takahashi and McDougal (2016, p. 519), “the topic of the research lesson should usually present some challenge for students or teachers”.

The response of MOE1 and MOE2 to the question of who set goals for lesson study in Zambian schools was that teachers were expected to set the goals.

According to MOE1, the authority to set goals for lesson study was embedded in the Zambian policy on education, Educating Our Future (MOE, 1996), which stated that all school-based CPD activities would be demand driven and initiated at the school level. Therefore, teachers had authority to drive lesson study activities at school level.

**Investigation of instructional materials**

MOE1 and MOE2 did not state the extent to which teachers investigated instructional materials when conducting lesson study. However, they said the Ministry provided teachers with instructional materials. According to MOE1, the Ministry provided “materials and other resources so that teachers can teach better and children can learn better”.

MOE2 stated that the National Education Support Team (NEST) produced or acquired resource materials that could help teachers conduct lesson study, mentioning the Teaching Skills Book as an example of such materials. However, the challenge, according to MOE2, was that NEST did not supervise teachers implementing lesson study at the school level, therefore, it was difficult to ascertain the extent to which teachers were using the instructional materials provided by NEST.
Sometimes you can take these materials to the teachers, and depending on the supervision at the local level, they may not be used. Meaning, the impact will not be felt, as we would want it to be. (MOE2)

**Observing the lesson**

According to MOE1, when one teacher presents the lesson, other members of the planning team sit and take notes.

One of them demonstrates the lesson; others sit to observe what is going on in that lesson and take down the points of discussion according to the way the lesson is going. (MOE1)

However, neither MOE1 nor MOE2 mentioned that people from outside the planning team should be invited to observe a lesson. The statement by MOE1, that observers take down the points of discussion according to the way the lesson is going, is similar to the statement in the *Implementation Guidelines* that, while one team member implements the lesson in a classroom, others observe and evaluate the lesson, with each observer focusing on assigned points of observation (MOE & JICA, 2010b). However, it is not clear, from either the perspective of MOE1 or the *Implementation Guidelines*, whether the focus of assigned points of observation should be students.

The term used by MOE1 to describe the observers, “the others sit to observe … and take down the points”, has little connection with Japanese research lessons where observers walk around “collecting data on how the lesson impacts the students, relative to the research theme and the learning goals” (Takahashi & McDougal, 2016, p. 520).

**Sharing lesson study results**

According to MOE2, one way to share lesson study results was through meetings between teachers and MESVTEE.

At times, we have meetings where we want to learn from them [teachers]; how they are implementing lesson study. We share, we exchange ideas, and then we advise where we can. Where we feel they could do better. As I said, it is an exchange. They also give us challenges in what we are proposing, and so on and so forth. At the end of it, all we try to come up with a model that will best suit them. (MOE2)
However, ISP2 raised his concern about the lack of documentation, stating that:

It’s now almost ten years or so practising lesson study. So with them [teachers], they have understood. But Ministry of Education’s concern is: I would want to see us document all the lessons developed as best practices. The lessons that I talked about can be developed into booklet form, maybe at Zonal level, school level and district level, so that we can keep because we have invested a lot of time and resources in developing these lessons. Therefore, to let go just like that, it would not be a good idea. (ISP2)

Sources of information on lesson study

Some respondents came to learn about lesson study through the training they received in Japan or Malaysia. ISP2 reported having been trained in Malaysia:

I also had a chance through the same JICA to go to Malaysia and part of the study we looked at lesson study in Japan. So we got the idea from the Japanese Lesson Study. However, we developed our own Zambian lesson study, which has got eight stages. (ISP2)

MOE1 stated that lesson study was an approach he learnt through collaboration with the Japanese people. MOE1 stated that he had acquired information on lesson study as follows:

In 2005, when Zambia introduced lesson study as a way for teacher professional development, we were trained at Mulungushi University in the practice of lesson study by colleagues from JICA, as well as colleagues who were trained earlier in Japan from the National Science Centre … and a few colleagues from Central Province who are the pioneers of lesson study. So I have picked it up through my own participation as a teacher at my former school and also as a co-ordinator of CPD activities in secondary schools when I was working as a resource centre co-ordinator. (MOE1)

ISP6 reported having participated in the JICA sponsored lesson study project in Kenya, stating that, “we were sponsored by JICA to get into Kenya to learn the skills, come back to train our colleagues”. Furthermore, he reported having obtained information about lesson study from the training in the lesson study Pilot Project in the Central Province of Zambia.
MOE2 said that he was part of the team that co-ordinated teacher education and spearheaded lesson study projects. He added that he was involved in the National Education Support Team (NEST).

ISP2 found lesson study information from SPRINT meetings in schools. She commented that SPRINT was the structure through which lesson study was introduced in schools. ISP4 commented that there was lesson study information flow between departments in the Ministry of Education.

Teacher Education found it fit and important to co-ordinate with us. So we’re in constant touch with Teacher Education so that information flows. Also, sometimes, other courses, which are designed to build the capacity of people that are involved in the advisory role at the NEST- that is National Education Support Team. (ISP4)

**Differences between lesson study and other CPD approaches**

ISP5 compared the cascade approach with the lesson study approach and explained that lesson study was school-based continuing professional development. She added that, more often than not, the cascade approach required someone from the district level to go to a school and train teachers. According to this respondent, the cascade system was not a school-owned program, but lesson study was owned by the school. As a result, lesson study was more valuable to the school than the cascade approach.

According to MOE1, lesson study was more effective as a continuing professional activity than other models because it used the classroom, where the teachers work, as a centre of learning for the teachers themselves. He added that teachers, while they are growing themselves, could also offer a service to the students. Teachers continued teaching, as they did not have to attend a college for them to become better teachers. He further compared lesson study to “peer teaching” that was implemented under SPRINT. The latter involved teachers pretending to be students and one of them presenting a lesson, after which they discussed the effects of the lesson on fellow teachers. However, according to MOE1, lesson study was more real because

lesson study is actually based in the classroom with actual students and therefore the reactions we will be getting will be more real. The challenges among the students in
terms of learning will also be real and if there’s good progress, I mean if the lesson is very effective, again it will be seen within the students themselves who are the intended beneficiaries of these activities which we do as teachers. That is the major difference between other practices of CPD and lesson study. (MOE1)

MOE2 also stated that lesson study is more collaborative than other CPD approaches.

According to ISP3, lesson study was more practical in the sense that people who attended lesson study were the ones who would directly approach the children. Therefore, the respondent believed that the amount of distortion of information was reduced.

ISP2 differentiated lesson study from other CPD approaches:

Lesson study is somehow different because it is more focused on a problem. You know the problem, identifies like how best can we teach trigonometric ratio. Then the focus will be there, finding the ways and after that, this is documented, unlike other CPD methods. (ISP2)

Further, ISP4 believed that

The lesson study structure cannot be distorted by any means. We have to follow that structure for us to implement lesson study... When it’s just lesson study, it has to follow its structure. (ISP4)

The above response resonates with the statement in the Implementation Guidelines that the “The lesson study cycle should be followed by respective schools” (MOE & JICA, 2010b, p. 20).

**What teachers learnt by participating in lesson study**

MOE1 stated that teachers’ practice could improve through team-work in lesson study. He stated that teachers had to keep collaborating with their colleagues for themselves to keep improving and become better teachers of mathematics.

Particularly in the area of mathematics; mathematics is technical subject and no one who has even a first degree in it can claim to know all the approaches there is to teach a particular topic, all the content there is for him to be an effective teacher. You
have to keep collaborating with your colleagues in order for you to keep improving and become a better practitioner as a teacher of mathematics. (MOE1)

ISP3 stated that lesson study offered an opportunity for teachers to learn that they needed each other to grow. ISP3 stated further that teachers needed each other to improve practice, while MOE2 stated that even teachers who are shy about speaking learnt something during lesson study.

According to ISP1, teachers participating in lesson study learnt “team planning” and “collaboration”. Similarly, ISP4 indicated that the planning aspect of lesson study was beneficial to teachers of mathematics.

According to ISP5, effective mathematics lessons were student-centred and not teacher-centred, with lesson study hopefully transforming traditional lecture-based lessons to student-centred lessons.

The traditional Zambian mathematic lesson is structured in such a way that it is more of teaching procedures rather than understanding of the concepts. Now through this lesson study, we hope we can turn the tables so that teachers teach for understanding rather than teaching algorithms. (ISP5)

ISP6 stated that teachers participating in lesson study learnt management skills. ISP4 specified that teachers participating in lesson study learnt how to generate appropriate teaching and learning materials to help them deliver mathematics concepts.

**Concerns about teachers participating in lesson study**

MOE2 stated that teachers and school administrators resisted lesson study when it was first rolled out in schools.

What I have just seen is a change, a slight change in attitude. When it was initially rolled out in 2013 … During the first term, there was a lot of resistance, and this resistance sadly enough comes from even head teachers. We had a workshop, it was so aggressive from the head teachers, and people were very negative. They thought it was going to be a total waste of time. (MOE2)
ISP1 and MOE1 raised a concern about teachers with a negative mindset, who felt they knew too much to attend lesson study. MOE1 explained that there were teachers who argued that they did not want to continue growing because they already had a Master’s degree in mathematics, and could not learn anything from lesson study. However, he felt that those teachers who claimed to know it all would enrich lesson study.

In fact, it is those same teachers whom we want to use at the Ministry of Education to help others grow. If indeed, they are so qualified in methodology and content, we want them to help us bring the other teachers to the same level as themselves.

(MOE1)

ISP1 added that such teachers just disadvantaged students. Similarly, ISP4 had concerns about those who thought they were better teachers. ISP2 and ISP4 were concerned about teachers’ lack of knowledge about lesson study or teachers who misunderstood lesson study.

ISP2 raised the concern that teachers did not understand the Zambian eight steps of lesson study and therefore were not implementing lesson study effectively. Similarly, ISP5 reported that lesson study was not well understood by all teachers and that some teachers looked at lesson study as an activity, which addressed only difficult topics to help them learn how to teach these topics.

Another concern for ISP4 was teachers who were pre-occupied with the urge see the immediate direct benefits of lesson study. ISP4 termed such an urge as a misunderstanding of lesson study.

According to two respondents, criticisms raised during the revision of the taught lesson and the post-lesson discussions were frequently aimed at attacking those who taught the research lessons. They also reported that even where the criticism was not meant to demean teachers who taught the research lesson, these felt that they were being attacked personally.

ISP5 stated that the quality of critique by teachers during post-lesson discussions may not help improve the quality of lessons when teachers implementing the research lessons felt that the critique was directed at them instead of the lesson. ISP5 concluded that many teachers were unwilling to be the research lesson teachers. This echoed the statement by MOE 2 who raised the concern that teachers, while acknowledging that the critique colleagues gave in lesson
study helped the presenter, had been reluctant to be critiqued. As a result, teachers could not complete the lesson study cycle in some cases.

Another concern raised by MOE1 was that inadequate resources were available for senior ranking officers from the Ministry of Education to monitor and support lesson study activities.

Sometimes we are not able to monitor and particularly give support to our provinces and districts because we do not have resources for us to procure fuel and travel to those provinces. (MOE1)

Another concern raised by ISP2 was that graduate teachers from colleges were not so familiar with lesson study. He said, “We would want to initiate them immediately they come. We orient them into lesson study so that they start practising [immediately]”.

### 4.3.2 In-service providers versus the Ministry definition

In-service providers had learned about lesson study through participating in training in lesson study in Japan and Malaysia, through a JICA-aided project in Kenya, and through the lesson study pilot project in the Central Province of Zambia. Some had attended SPRINT Workshops in Zambian schools. According to the in-service providers, lesson study had features that differentiated it from other CPD approaches. In particular, it was school-owned and supported by school administrators, it focussed on a problem, and involved documenting and sharing the results.

There were few differences between in-service providers’ interpretation and of lesson study in the Ministry of Education’s definition. This was partly because the in-service providers interpreted lesson study based on the Ministry publications. However, the Ministry documents focussed on both the functional perspective (how lesson study is practised and what it intends to achieve) and the process perspective (the eight steps of the Zambian lesson study cycle), whereas the in-service providers seemed to view lesson study only from the process perspective.

A notable similarity was the perception that the eight steps of the Zambia lesson study model were rigid, with the *Implementation Guidelines* stating that the “lesson study cycle should be followed by respective schools as outlined” (MOE & JICA, 2010b, p. 20). However, the in-service providers had some concerns about teachers participating in lesson study. They
had concerns that some teachers were reluctant to participate in lesson study, and that some teachers who knew very little about lesson study might not implement it well. They were also concerned that some teachers failed to follow the eight steps of the Zambian lesson study cycle.

Both the Ministry documents and the in-service providers were sceptical that schools complied with the directive from the Ministry that schools should implement one lesson study cycle every month. The Implementation Guidelines acknowledged the claims by schools that they had inadequate time for implementing lesson study.

Many teachers and school managers say there is little or no time to conduct CPD due to various programs running in schools and personal matters. (MOE & JICA, 2010b, p. 45)

However, the Ministry was sceptical that schools really had no time to conduct the required lesson study cycles, stating that while teachers should work for 8 hours a day, many left immediately they finished teaching. Further, the Ministry stated that each school should have a master plan for its activities, and ensure effective supervision (MOE & JICA, 2010b).

The in-service providers mentioned that the lesson study approach involved the documenting and sharing of results, which falls under Step 8: Reflections compiled and shared (termly) of the Zambia lesson study model (MOE & JICA, 2010B). According to the Implementation Guidelines, teachers should record the post-lesson discussion and file it as a school CPD report. The report should be submitted to the district office, where its contents are summarised by the District Education Support Team and shared with other schools in the next stakeholders’ workshop. If the lesson study results are regarded as outstanding, they will be shared at conferences (MOE & JICA, 2010b).

Both the Ministry documents and the in-service providers stated concern that teachers with a poor attitude towards lesson study were reluctant to participate in lesson study. The Implementation Guidelines had anticipated this challenge.

Some teachers do not understand and appreciate the need of attending CPD because they could have been in service for a long time; after graduating from teacher training institutions/colleges, for others, teaching was not their first choice career, while others just were lazy and uninterested. (MOE & JICA, 2010b, p. 47)
The concern by in-service providers that teachers wanted to see the benefits of lesson study immediately needs some comment. In addition to the benefits of lesson study related to improvements in teaching and learning, and student achievement, teachers might expect to receive sitting allowances (money) for participating in lesson study. For decades, teachers have perceived CPD workshops as a source of income. The Implementation Guidelines stated that a culture of perceiving workshops as a means of extra income had entered the minds of many people and teachers were not an exception.

4.4 School administrators’ interpretation of lesson study

At each of the three case schools, interviews were conducted with the head teacher (referred to here as HTA, HTB, HTC), and the CPD co-ordinator (referred to here as CA and CC).

4.4.1 School administrators’ interview responses

This section focusses on the responses of these participants in terms of their understanding of lesson study, sources of information on lesson study, how lesson study differs from other CPD approaches, what teachers learnt by participating in lesson study, and any concerns they had about teachers participating in lesson study.

Understanding of lesson study

Three of the five school administrators described lesson study by highlighting what it aimed to achieve. According to CA, lesson study was an approach that enhanced teaching and learning activities in schools. For HTC, lesson study was “an approach to train”. HTA stated that by participating in lesson study teachers who felt inadequate were able to deliver a lesson more effectively. Further, HTA stated that lesson study aimed to help teachers improve their lessons. These aims, are similar to the aims for Japanese Lesson Study noted by Takahashi and McDougal (2016).

According to CC and HTA, lesson study had steps that teachers should follow. CC stated that lesson study was a cycle in which teachers collectively defined a challenging problem, planned and implemented the plan, reflected on whether their plan had worked, and
tested the plan in another class. Unlike Japanese Lesson Study, the above statement, “tested the plan in another class”, implied that re-teaching a revised lesson might not be negotiable.

HTA commented on one stage of the lesson study cycle – the post-lesson discussion. He stated that while attending training in Japan, he was impressed that Japanese teachers engaged in lesson study freely. He noted that the teacher who had taught the research lesson spoke first during the post-lesson discussion, highlighting what could have been done better. After that, others analysed the lesson. The atmosphere motivated others to contribute to the discussion.

According to CC, HTA, and HTC, lesson study is driven by challenging topics or problems. CC, for example, stated that lesson study involved teachers bringing up a problem everyone thought required a solution. Similarly, HTC commented that lesson study involved identifying a challenge in a particular topic, how to use materials, and the content or the methodology. HTA stated that lesson study involved identifying areas where a lesson could be improved.

**Sources of information on lesson study**

According to CC, books on lesson study from SPRINT – particularly the *Teaching Skills Book* and the *Implementation Guidelines* – helped them learn about lesson study.

We have various books, which help us from the SPRINT. I think the people who organised the CPD brought in. I think it’s JICA. I believe they have provided various books, which we use. I have a number of them. There is this School-based CPD Teaching Skills Book, and then there are Implementation Guidelines. They help us. (CC)

CA stated that he found information through JICA lesson study training workshops in Zambia, as did HTC. HTB focussed on information about lesson study from a group of teachers who had been sent to Kenya where a lesson study program had been implemented.

**Differences between lesson study and other CPD approaches**

HA believed that lesson study was more practical than other CPD approaches, such as the cascade approach.
But lesson study is practical. I like it because it is practical. You don’t just prepare the lesson, no. You move into the class and actually teach that lesson, and then come back and sit down, criticise the lesson. Again, if you are not satisfied you go back and re-teach. You know until you reach a point where you think now we have developed a standard lesson, you file it even for other teachers who may come later and use it. So, I think there is a difference. It’s more practical. (HA)

According to CC, lesson study was different from other CPD approaches because lesson study had no “masters” – those who could exalt themselves as “know it all” individuals. He further stated that, unlike other CPD approaches where one individual attended some training and become a super-teacher, lesson study promoted levelling of understanding among teachers.

**What teachers learnt by participating in lesson study**

According to CA, HTA and HTB, teachers participating in lesson study learnt how to deliver lessons. According to CA,

> Teachers who are participating in the lesson study learn quite a lot. They are looking at the new methods of teaching where you are running away from the usual lesson. What do you call it? Lecture method. But this time around, students are more involved. So those techniques are discussed in more detail. (CA)

The quote from CA resonates with HTB’s comment that teachers learnt “how to approach such a topic, so the delivery method also improves”. Also, HTA stated that even teachers who considered themselves as inadequate in delivering certain topics were helped during lesson study to deliver a lesson more effectively than if they had done it alone.

CC, referring to what teachers participating in lesson study stated, “Approaches change. We no longer feel that a child knows nothing apart from a teacher”. Furthermore, HTB stated that teachers expanded their knowledge in mathematics by participating in lesson study.

> They will deepen their knowledge because as you may be aware, they say knowledge is not a preserve of only one person. So maybe one teacher could be well vested
HTC said that teachers learnt concepts and skills and, after developing the concepts and skills, could focus better on the real issues.

**Concerns about teachers participating in lesson study**

According to CC, newly graduated teachers were reluctant to attend lesson study because universities did not inform them about the need to participate in CPD when employed in schools or they felt they already knew it all. HTB was also concerned that some teachers thought lesson study was a waste of time.

HTA reported concerns about inadequate time to engage in lesson study, while at the same time having the challenge of covering the syllabus. He added, “It's only time, [it] doesn’t seem to be adequate to do everything that we want to do”.

HTC was concerned that teachers who did not understand lesson study were focussing on physical benefits, such as the refreshments some schools provided during lesson study. She said that some teachers did not want to participate in the lesson study sessions if the school did not provide refreshments.

**4.4.2 School administrators versus in-service providers**

As was the case with the in-service providers, school administrators had been exposed to Japanese experts on lesson study, some during training in Japan, and others when participating in the JICA-aided projects in the Central Province of Zambia or Kenya. However, school administrators also mentioned gaining additional information about lesson study from the *Teaching Skills Book* (MOE & JICA, 2009) and the *Implementation Guidelines* (MOE & JICA, 2010b). However, school administrators did not mention many of the features of Japanese Lesson Study such as: a long-term goal, a clear research purpose, significant time spent on investigating a wide range of instruction material, engagement of knowledgeable others, the period over which one lesson study cycle was conducted, and sharing of lesson study results. These features are pertinent to Japanese Lesson Study. For example, Takahashi and Yoshida (2004) noted that the meticulous analyses of academic content and teaching materials are
integral to lesson study as practised in Japan.

Both the school administrators and the in-service providers stated that lesson study would build the expertise of teachers. However, the school administrators mentioned more aspects of lesson study than the in-service providers did. This difference might be explained by the fact that school administrators worked within the environment where lesson study took place.

According to the school administrators, lesson study differed from other CPD approaches because it was more practical than the cascade approach, which involved sending one teacher or a group of teachers, for training, and having to present to their colleagues on their return. The school administrators focussed more on the impartiality of lesson study, stating that all teachers participating had same opportunities to contribute and learn, with no “masters” exalting themselves as having all the knowledge. The in-service providers, on the other hand, focussed more on the lesson study process, that is, the eight steps that teachers must follow, including documenting and sharing of results. They saw the eight steps as rigid, as per the statement in the *Implementation Guidelines* (MOE & JICA, 2010b, p. 20).

There were no major differences between the perceptions of the school administrators and the in-service providers regarding what teachers learnt when participating in lesson study, with school administrators stating that teachers who participated in lesson study learnt how to approach difficult topics and teach a lesson more effectively. They believed that teachers also no longer felt that students knew nothing apart from the information provided by their teachers, and that teachers expanded their knowledge of mathematics through lesson study.

The school administrators were concerned that many newly graduated teachers from universities were reluctant to attend lesson study, and some teachers thought lesson study was a waste of time, with in-service providers also being concerned about teachers with a poor attitude towards lesson study who were reluctant to participate in lesson study. The school administrators also expressed concern that teachers did not have adequate time to engage in lesson study, while at the same time having to cover the school syllabus, and that teachers were focussing on the monetary and physical benefits of lesson study, such as the refreshments that some schools provided.
4.5 Mathematics teachers’ interpretations of lesson study

At each of the three case schools, interviews were conducted with the two teachers who taught the research lessons (referred to here as TA1, TA2, TB1, TB2, TC1, and TC2).

4.5.1 Mathematics teachers’ interview responses

This section focuses on the responses of these participants in terms of their understanding of lesson study, sources of information on lesson study, and how lesson study differs from other CPD approaches.

Understanding of lesson study

Teachers expressed various views on lesson study. TA1 saw lesson study mainly as a student-centred approach, which simplified the lesson presentation, and enabled teachers to use the available teaching aids. He added that lesson study was used mostly in mathematics because lesson study helped to translate the abstract terms in mathematics to real-life situations through lesson plans, thereby helping students to understand mathematics.

According to TA2, the objective of lesson study was to improve the effectiveness of lesson preparation. TB1 stated that lesson study is a cycle in which teachers, working as a team, planned the lesson; allowed one teacher to implement the lesson; evaluated the lesson; made amendments; and repeated the same lesson in a different class.

TC1 and TC2 depicted lesson study as being driven by challenging topics or problems. According to TC1, lesson study involved teachers in a department identifying a challenge and assessing whether they could address them. Similarly, TC2 said that in lesson study teachers should look at challenging topics and how best to teach such topics.

Sources of lesson study information

TC1 stated that “timely information books” were the source of lesson study information, while TA1 reported that head teachers who had been trained in lesson study in Japan taught others about lesson study with SPRINT being the school CPD forum for teaching others. Similarly, TB1 reported having sourced lesson study information within the school from teachers who had attended lesson study workshops.
Differences between lesson study and other CPD approaches

According to TB2, lesson study differed from other CPD approaches because teachers make a lesson plan together, thereby enabling teachers to discover areas with some challenges. Furthermore, TB2 said that lesson study helped both the teachers and students understand concepts properly.

According to TA1, unlike lessons study, other CPD approaches sometimes resulted in teachers being sent for training outside the school, only to come back and fail to implement what they had learnt.

Sometimes when a teacher sent somewhere comes back, he wouldn’t be able to teach. But if like we had one today, and then you can sit down and plan. Go to the class, come, and discuss again. You find that it becomes more of the something, which will be able to apply, and something that would be able to improve on. (TA1)

TA2 said that it was too early to compare lesson study with other CPD methods because lesson study in School A had been implemented for less than three years.

4.5.2 Mathematics teachers versus school administrators

Unlike the school administrators and in-service providers, who seemed to have been exposed to Japanese experts on lesson study – some during their training in Japan, and others when participating in JICA-aided projects in the Central Province of Zambia or Kenya – the teachers seem to have sourced information on lesson study from within their schools, through a cascade approach.

At School A, both the school administrators and the two teachers that the researcher interviewed understood lesson study from what it aimed to achieve. However, the school administrators, also pointed out the lesson study process (cycle) and some of its essential features.

At School B, the two teachers and the school administrators understood lesson study as a process through which teachers could be helped to address challenging topics or problems.

Similarly at School C, both the school administrators and the two teachers understood lesson study from the point of view of what it aimed to achieve. However, school administrators focused further on the process.
At Schools B and C, the school administrators and the teachers regarded lesson study as being superior to other CPD approaches that relied on a cascade model with teachers being sent out for training but, on their return, failing to implement what they had learnt.

However, at School A, one teacher was not convinced that lesson study was more effective than other CPD approaches at their school.

4.6 Conclusion

The Zambian Ministry of Education identified three primary areas of mathematics education that required reform: teacher-centred instruction, the mathematics curriculum, and continuing professional development of mathematics teachers (MOE, 1996). It introduced lesson study to transform the teacher-centred lessons to student-centred lessons, and to enhance continuing professional development of mathematics teachers (MOE & JICA, 2010a).

The Ministry defined the Zambian lesson study model substantively in three key publications – the Implementation Guidelines (MOE & JICA, 2010b), the Teaching Skills Book (MOE & JICA, 2009), and the Master Plan (MOE & JICA, 2010c). These key publications describe in detail the eight-step lesson study cycle; the responsibilities of in-service providers, school administrators and teachers; and the challenges in implementing lesson study in schools.

Based on the Ministry publications and the interviews, the conceptualisation of what lesson study aims to achieve in Zambia across the Ministry (Ring 1 of the Onion Rings Model), the In-service providers (Ring 2), the School administrators (Ring 3) and the Teachers (Ring 4) appear to be threefold: to help the Ministry achieve the goals of the Zambian education system (Ring 1); to transform teacher-centred lessons to student-centred lessons (Rings 1, 2 and 4); and to help teachers address the topics they find difficult when teaching mathematics (Rings 3 and 4). These aims are in line with the National Policy on Education, which states that the goals of the education system should inform the education policies and practices of all partners in the provision of education and be the basis for teaching and learning in schools and colleges of education (MOE, 1996).

The interpretation of the Zambian lesson study model varied between in-service providers, school administrators and teachers, with in-service providers and school administrators interpreting the model more accurately than the teachers did. This is unsurprising
as the former had been exposed to Japanese experts while the latter learnt about lesson study through a cascade approach. Moreover, the in-service providers who were responsible for supporting schools to implement lesson study according to the policy documents were involved in the rolling out the lesson to 10 provinces and had become monitors instead of supporters of lesson study.

There was consensus across all the four levels of the education system (Rings 1 to 4) that lesson study is different from other CPD approaches that the Ministry had used previously. Unlike other CPD approaches, lesson study can train many teachers at once (Ring 1); is school-owned, more effective, and collaborative (Ring 2); more practical and does not have “I know it all” teachers (Ring 3); and mathematics teachers claimed not to have enough time for lesson study because of the overload from the syllabus (Ring 4).

Unlike Rings 1 to 3, where information about lesson study was sourced directly from Japanese experts (in Japan, Kenya or Zambia), the participants in Ring 4 sourced information from non-Japanese experts – through key Ministry documents and a cascade model, through which those who had been trained by Japanese experts transmitted the information to teachers. Although the cascade approach reaches many participants in a short period of time (Leu, 2004) and is cost effective (Hayes, 2000; Ono & Ferreira, 2010), there is a strong likelihood of transmitting misinterpreted crucial information (Fiske & Ladd, 2004) and does not offer follow-up support structures for teachers involved in the long-term implementation of the new reforms (Robinson & Carrington, 2002). These reasons may explain why the teachers (Ring 4) seem to show a superficial understanding of lesson study. The cascade method tends to fall under what Ebaeguin and Stephens (2015) referred to as fidelity approach that treats lesson study “as just another program[me] or ‘package’ to be copied and not ways of thinking and habits that support good teaching and professional learning” (p. 377).

The definition of lesson study by the Ministry understated the role the knowledgeable others can play in enriching lesson study in Zambia. The policy treats the knowledgeable others from higher institutions as mere observers and does not state that they should be asked to give insights into the research lesson and what teachers could learn from the lesson.

These findings have implications for understanding the mechanisms put in place to support lesson study (SQ2) and the actual implementation of lesson study by teachers (SQ3), which will be explored in the next two chapters.
Chapter 5 Lesson study support mechanisms

This chapter addresses the subsidiary question *SQ 2: What mechanisms have been put in place to establish lesson study as a model for professional development in Zambian schools?* It is based on an analysis of the key Zambian Ministry of Education publications and interview data, guided by the Onion Rings Model as shown in Figure 3.2.

5.1 Ministry lesson study support mechanisms

Three Ministry documents were analysed to establish what support mechanisms were envisaged being used to support the implementation of lesson study in Zambia.

5.1.1 Key publications

The documents analysed for lesson study support mechanisms were the *Educating Our Future: National Policy on Education* (MOE, 1996) – hereafter referred to as *Educating Our Future* – the *School-Based Continuing Professional Development Implementation Guidelines* (MOE & JICA, 2010b) – hereafter referred to as the *Implementation Guidelines* – and *The master plan for strategic expansion and implementation of school-based CPD programme 2010-2023* (MOE, 2010) – hereafter referred to as the *Master Plan*. The analysis of these documents shows that the Ministry had put in place lesson study support structures at national, provincial, district, zone and school levels.

Chapter 11, The Teaching Profession, of *Educating Our Future* identified existing gaps in the teaching profession and stated the policies and strategies to address these gaps. According to *Educating Our Future*, teacher education was “a continuing process that must be extended throughout the individual’s years of actual teaching” (MOE, 1996, p. 115). Therefore, pre-service courses offered in colleges of education and the university were necessary but not sufficient. In light of this, *Educating Our Future* urged teachers to be responsible to themselves and to their profession by deepening their knowledge, extending their professional skills and having up-to-date information on major changes affecting their profession.

Furthermore, *Educating Our Future* stated that an education system should be dynamic, promoting change in response to the needs and expectations of society, in areas such
as subject content, school management and organisation, and relationships with parents and the community. As already stated in Chapter 2, the *Literature Review*, a major public expectation in Zambia was improved student performance in mathematics. For example, Professor Lungwangwa, while holding the office of Minister of Education in Zambia, stated that:

> As a nation, we cannot lag behind in Mathematics, Science and Technology because these subjects are cardinal to national development. Statistics indicate that 40 percent of children who sat for last year’s [2008] school certificate examination failed mathematics. (Lungwangwa, as quoted by Lusaka Times, March 28, 2009, 8:11 am)

Lungwangwa further implored all colleges of education, as well as the entire Ministry of Education, to devise and implement strategies to address poor performance in mathematics, science and technology.

To address deficiencies in the teaching profession, *Educating Our Future* outlined eight policies, as shown in Figure 5.1.

Policies 1 and 2 addressed the quality of individual teachers and in-service professional development. *Educating Our Future* also provided strategies for addressing the identified deficiencies in the teaching profession. Strategy 9 focussed on promoting school-based in-service professional development programmes, stating “In-service training programmes will be based on identified needs of teachers and the education system, and will be predominantly school-based, with extensive involvement of Resource Centres” (MOE, 1996, p. 123). Lesson study fitted with this strategy because lesson study is school-based.
The Teaching Profession

Policy

1. In order to foster the quality and effectiveness of the education system, the Ministry of Education will promote the quality of individual teachers and of the teaching profession as a whole.

2. The Ministry acknowledges that the two pillars on which the professional competence of teachers rests are initial training and ongoing in-career professional and personal development.

3. Organizational arrangements for the training of teachers will take increasing account of the way the school system is structured into basic and high schools.

4. The Ministry will pursue various options in order to increase the supply of trained teachers for basic and high schools.

5. The Ministry will formulate broad guidelines and strategic approaches for the in-service education and training of teachers and will exercise a coordinating role in respect of such training.

6. Recognizing that terms and conditions of service crucially affect the morale and commitment of teachers, the Ministry will strive to have these improved.

7. The Ministry recognizes the need for a professional teachers' body that would set and maintain the highest professional standards among teachers.

8. The arrangement whereby the Ministry and religious bodies collaborate to provide pre-service teacher education will continue and will, if possible, be extended to include other partners.

Figure 5.1. Policy on the teaching profession (MOE, 1996, p. 122)

The Implementation Guidelines (MOE & JICA, 2010b) described the School Program of In-service for the Term (SPRINT) as a framework for School-Based Continuing Professional Development (SBCPD).

SPRINT, was introduced in Zambia in 1996 as a way of hastening and decentralising in-service operations. It was designed, for teachers based in schools, and supported by Teachers’ Resource Centres and In-service Co-ordinators. SPRINT involved small Teacher Groups that
met regularly to discuss professional issues. SPRINT was introduced to avoid duplication of interventions, and to streamline the operations of in-service provision.

According to the *Implementation Guidelines*, the lesson study approach “fitted perfectly” with SPRINT:

Lesson study has fitted perfectly as a mechanism to strengthen SPRINT in both basic and high schools. Within the SPRINT framework, lesson study can be practised as shown in the diagram below. There are five major activities in SPRINT which can provide a forum for conducting lesson study. (MOE & JICA, 2010b, p. 2)

The *Implementation Guidelines* claimed that SPRINT was an appropriate forum for conducting lesson study because:

- Many teachers are reached on a continuous basis at minimum cost.
- It ensures minimum disturbance of the learning of students, since training takes place in schools or resource centres nearby.
- The focus is on improving teaching and learning in the classroom in which teachers act as agents of change.
- It promotes mutual learning hence no need for trainer of trainers.
- Government and Local resources are used.
- Capacities of teachers and head teachers are developed simultaneously. (MOE & JICA, 2010b, p. 5).

The *Implementation Guidelines* specified the number of lesson studies and workshops schools should conduct each term. There should be a minimum of seven lesson study cycles in a year, with three cycles in Terms 1 and 2, and one cycle in Term 3. Table 5.1 shows the annual timetable for workshops and lesson study.
Table 5.1. Annual timetable for workshops and lesson study  
(Source: MOE & JICA, 2010b, p. 13)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
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<th>Sep</th>
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<tr>
<td>Stakeholders’ workshop</td>
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<td>1</td>
<td>2</td>
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<td>Facilitators’ workshop</td>
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<td>At least once in a year preferably during school holidays</td>
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<tr>
<td>Lesson study cycles</td>
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<td></td>
<td>1-1</td>
<td>1-2</td>
<td>1-3*</td>
<td>2-1</td>
<td>2-2</td>
<td>2-3</td>
<td>3-1</td>
<td></td>
</tr>
<tr>
<td><strong>2nd year</strong></td>
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<td>Stakeholders’ workshop</td>
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<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Stakeholders’ workshop</td>
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<td></td>
<td></td>
<td>At least once in a year preferably during school holidays</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lesson study cycles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4-1</td>
<td>4-2</td>
<td>4-3</td>
<td>5-1</td>
<td>5-2</td>
<td>5-3</td>
<td>6.1</td>
<td></td>
</tr>
</tbody>
</table>

Note: 1-3 denotes the 3rd lesson study cycle in Term 1.

As stated in the Implementation Guidelines, Stakeholders’ workshops were held at the provincial, district or zone level. These workshops were facilitated and monitored by the Provincial Education Support Team (PEST) and the District Education Support Team (DEST). As can be seen in Figure 5.2, large numbers of participants attended stakeholders’ workshops. The participants included School INSET Co-ordinators (SIC), Zone INSET Co-ordinators (ZIC), some class teachers, Facilitators, Heads of Department or Section, Senior Teachers, Deputy Headteachers and Headteachers (MOE & JICA, 2010b).

Lasting two to three days, and taking the form of a conference (see, Figure 5.2), the workshops aimed to make stakeholders: aware of the framework for implementing lesson study and the roles to be played; exchange information and experiences on the implementation of lesson study in order to improve classroom practice; address needy areas; compare their performance with others; to learn new knowledge; and acquire new skills school (MOE & JICA, 2010b).
Figure 5.2. A photo of a Stakeholder Workshop (Source: MOE & JICA, 2010b, p. 14)

Table 5.2 shows the programme for a typical Stakeholders’ Workshop.

Table 5.2 Proposed programme design for Stakeholders’ Workshop
(Source: MOE & JICA, 2010b, p. 14)

<table>
<thead>
<tr>
<th>Day</th>
<th>Activity</th>
<th>Participants</th>
<th>Facilitators</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plenary: <em>Orientation of participants in lesson study Cycles</em></td>
<td>Facilitators, Headteachers, HODs, Senior Teachers, Deputy Headteachers, DEST* and ZEST*</td>
<td>Identified facilitators</td>
</tr>
<tr>
<td>2</td>
<td>Group session: <em>Input on facilitation skills and subject content</em></td>
<td>Facilitators, HODs, Senior Teachers, Deputy Headteachers, DEST and ZEST</td>
<td>Identified facilitators</td>
</tr>
<tr>
<td></td>
<td>Group session: <em>Foundation of school management</em></td>
<td>Headteachers</td>
<td>Identified facilitators</td>
</tr>
<tr>
<td>3</td>
<td>Group session: <em>Demonstration of facilitation (Practice of Lesson Study)</em></td>
<td>Facilitators, HODs, Senior Teachers and Deputy Headteachers, DEST and ZEST</td>
<td>Identified facilitators</td>
</tr>
<tr>
<td></td>
<td>Group session: <em>Management of School-Based CPD</em></td>
<td>Headteachers</td>
<td>Identified facilitators</td>
</tr>
</tbody>
</table>

* DEST – District Education Support Team; ZEST – Zone Education Support Team
Similarly, Facilitators’ Workshops were held at the provincial, district or zone level. Each workshop was “a forum for facilitators to have additional inputs on their skills of facilitation and ideas for conducting practical works in schools” (MOE & JICA, 2010b, p. 16). Facilitators’ Workshops aimed to help facilitators: augment their facilitation skills; become aware of the topic focus for lesson study each term; master the content and develop ideas for practical work in each subject; develop a plan of action for presentation to stakeholders during the Stakeholders’ Workshop; and consolidate progress reports on facilitation of lesson study (MOE & JICA, 2010b).

The Ministry of Education, in collaboration with the Japanese International Co-operation Agency (JICA), implemented the Strengthening Mathematics, Science and Technology Education (SMASTE) School-Based Continuing Professional Development through lesson study project in 2005 in Central Province. The project was implemented in North Western and Copperbelt Provinces in 2008. The Ministry had intended to roll out the project to the remaining six provinces of Zambia, and to effect that, the Ministry developed the Master Plan for strategic expansion of School-Based Continuing Professional Development (SBCPD) programme 2010-2030 – the Master Plan.

The Master Plan highlighted the key strategies that would be used to expand the project using the experience gained in three pilot provinces (Central, North Western and Copperbelt Provinces) and the current School Program for In-service for the Term (SPRINT). The Master Plan outlined seven steps for rolling out lesson study to the remaining six provinces.

1. **Orientation of Standards Officers, Provincial Education Support Team (PEST), District Education Support Team (DEST) and other levels of implementation**: The National Education Support (NEST) would spearhead the orientation. The three provinces (Central, North Western and Copperbelt Provinces) that were conducting lesson study would support the introduction of lesson study in new provinces.

2. **Introduction of lesson study approach into SPRINT Framework**: PEST in each province, in liaison with NEST and DEST, would strategise on how to introduce lesson study in the SPRINT Framework.

3. **Selection of lesson study facilitators and facilitator training (capacity building) and induction programmes for newly appointed teachers**: PEST and DEST would select facilitators.
4. Planning and conducting management training: Build capacities of head teachers to effectively and more efficiently support CPD activities at school level.

5. Conduct of 1st Stakeholders’ and Facilitators’ workshops in each province: The workshops would be for school head teachers, deputy heads and facilitators at the provincial level.

6. Introduction of lesson study in schools in each province: Schools should include lesson study in their term plans and start conducting lesson study.

7. Monitoring and assistance to schools by PEST and DEST in co-ordination with NEST and supporting provinces: PEST and DEST would conduct monitoring lesson study and provide assistance to schools to conduct lesson study according to the Implementation Guidelines. (MOE, 2010, p. 12)

The Implementation Guidelines described anticipated challenges in the implementation of lesson study and proposed counter-measures. These are summarised in Table 5.3.

In Table 5.3, some countermeasures have specified the people responsible for their implementation. For example, school managers were responsible for implementing the countermeasures for the negative attitude of some teachers. According to the Implementation Guidelines, the negative attitude of some teachers were a function of several factors:

Some teachers do not understand and appreciate the need of attending CPD, because they could have been in service for a long time; after graduating from teacher training institutions/colleges, for others, teaching was not their first choice career, while others just were lazy and uninterested. (MOE & JICA, 2010b, p. 47)

However, some countermeasures stated in Table 5.3 had no-one specified to implement them. For example, there was no mention of the people responsible for implementing the counter-measures for insufficient skills of teachers and facilitators for good lesson critiquing and lack of confidence.
<table>
<thead>
<tr>
<th>Anticipated challenges</th>
<th>Countermeasures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low commitment to school management on professional development of teachers</td>
<td>• School management should participants at the stakeholders’ workshops, a session for them should be organised for them to deepen their managerial skills and commitment to the CPD programmes.</td>
</tr>
<tr>
<td></td>
<td>• Take school managers to model schools implementing effective CPDs so that they could start comparing themselves with those good models.</td>
</tr>
<tr>
<td></td>
<td>• Provincial and district officers should monitor school managers and CPD activities implemented in schools.</td>
</tr>
<tr>
<td>Time management:</td>
<td>• Inculcate the culture of working for 8 hours a day in teachers. School managers should not allow teachers to knock off immediately they finish teaching their lessons.</td>
</tr>
<tr>
<td>(inadequate time at school for implementing lesson study)</td>
<td>• The school deputy heads, in consultation with the HODs and Senior Teachers or SIC and ZICs, should make a master plan for the school activities.</td>
</tr>
<tr>
<td></td>
<td>• School managers should orient teachers that proper and effective study as professionals required certain time and efforts. There was no easy way for learning.</td>
</tr>
<tr>
<td>Difficulties in monitoring &amp; creating school clusters caused by geographical location of schools</td>
<td>• Arrange clusters so that teachers from small schools can have opportunities to attend CPD meeting in the cluster. Re-arrange clusters if teachers have to take a long trip to other schools.</td>
</tr>
<tr>
<td></td>
<td>• Consider procuring bicycles as a cost-effective way to assist teachers to move in cluster.</td>
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<tr>
<td></td>
<td>• Provincial and district officers should make a proper plan for monitoring lesson study.</td>
</tr>
<tr>
<td></td>
<td>• Strengthen capacity at lower levels, especially Zonal Heads, in order to generate authentic lesson study reports.</td>
</tr>
<tr>
<td>Paradigm shift on perceiving workshops as a source of income</td>
<td>• Make teachers understand and appreciate the benefits of their professional development.</td>
</tr>
<tr>
<td></td>
<td>• Made teachers aware that they should not be paid for their personal professional development and that benefits are not always financial.</td>
</tr>
<tr>
<td>Negative attitude of some teachers</td>
<td>School managers should:</td>
</tr>
<tr>
<td></td>
<td>• Orient and sensitisise teachers on the importance of CPD.</td>
</tr>
<tr>
<td></td>
<td>• Make efforts to try involving those teachers in a team of other teachers.</td>
</tr>
<tr>
<td></td>
<td>• Use the successful model of their colleagues as peer educators.</td>
</tr>
<tr>
<td></td>
<td>• Apply appropriate administrative measures at all levels.</td>
</tr>
</tbody>
</table>
Insufficient skills of teachers & facilitators for good lesson critiquing and lack of confidence.  
- Conduct training workshops for the facilitators as an ongoing activity, which enables them to continuously, learn lesson-critiquing skills.  
- Orient teachers on the difference between lesson critiquing and criticizing the teacher.  
- Encourage teachers to exchange comments and suggestions for improving their lessons.

Inadequate materials and necessary information for teachers to use as tools to improve their competence  
- Maximise the use of available resources, while developing those which could be done within our own means.  
- Make improvised teaching materials with locally available resources.  
- Procure more materials with funds from income generating activities within a school.  
- Network the Zone centres as a long-term goal.

Limited number of qualified teachers of science and mathematics in schools  
- Conducting lesson study meetings across departments or having them in clusters.

Devising content for SBCPD meetings  
- Capacity development of teachers in problem identification, analysis and resolution.

### 5.1.2 Zambian lesson study support mechanisms versus Japan

Table 5.4 compares the lesson study support sources in Zambia and Japan.

<table>
<thead>
<tr>
<th>Source of support</th>
<th>Lesson study in Zambia</th>
<th>Lesson study in Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy</td>
<td>Lesson study is a formal requirement. Educators in schools, districts, and provinces, and in national organizations support lesson study as a way to achieve the vision of the Ministry of Education (MOE &amp; JICA, 2010b).</td>
<td>There are no formal requirements to do lesson study. Responsibility for lesson study is distributed (Spillane, Diamond, &amp; Jita, 2003). Educators in schools, in districts, in regions, and in national organizations see lesson study as a way to achieve their own educational visions, not as an imposed practice (Lewis, 2013).</td>
</tr>
</tbody>
</table>
Structures | Lesson study has been institutionalised within the SPRINT framework. Structures have been established at national level (e.g. NEST and Kyozaikenkyu Team); provincial level (e.g. PEST); district level (e.g. DEST); and school level (e.g. SEST) to support lesson study activities. | School structures (e.g., a Research Steering Committee) support lesson study by creating a year-long lesson study calendar and plan (Wang-Iverson & Yoshida, 2005, Takahashi, 2014). Advancement systems support lesson study, since it is unthinkable that a teacher could become an instructional supervisor or principal without a strong track record of lesson study (Lewis, 2013).

Financial | The Ministry funds lesson study activities at national, provincial, district and school levels. | The Japanese Ministry of Education, Culture, Sports, Science and Technology is not obliged to fund lesson study. However, JICA is instrumental in funding lesson study projects that involve the training of educators from other countries.

Curriculum | Lesson study should be used to implement the new school curriculum. | Frugal Japanese mathematics curriculum supports lesson study (Groves & Doig, 2010).

Culture | Many aspects of Zambian culture need to change (e.g. teacher viewing lesson study as a means of making extra income (MOE & JICA, 2010b) | Lesson study is accepted as a normal part of education.

Beliefs about lesson study | Some Zambian teachers regard lesson study as a waste of time partly because of competing demands on limited available time (MOE & JICA, 2010b) | Lesson study is valued as a means of continuing professional development.

Knowledge from lesson study | The knowledge from the pilot lesson study project led to the development of the Implementation Guidelines, the Teaching Skills Book, and the Management Skills Book | Policymakers attend large public research lessons and may use what they learn to reshape policy (Lewis, 2013). Commercial textbook publishers rewrite textbooks in response to lesson study (Lewis, Touched & Coleman, 2002; ).

### 5.2 In-service providers’ views on lesson study support

Interviews were conducted with two officers from the Ministry Headquarters (MOE1 and MOE2), and six in-service providers comprising three District Education Board Secretaries and three District Education Standards Officers (hereafter referred to as ISP1–ISP6).
5.2.1 In-service providers’ interview responses

This section focusses on views of the in-service providers regarding the mechanisms put in place to support the implementation of lesson study.

School Program of In-service Training for the Term

The School Program of In-service Training for the Term (SPRINT) programme was identified as a framework for supporting lesson study implementation in Zambia. MOE1 was of the opinion that JICA were pleased with SPRINT, stating:

Incidentally, when the Japanese were interacting with several African countries with the view to assist them to implement a structure, which could promote the growth of teachers, they were very pleased with the SPRINT system we have in this country, which is very similar to their system back home. They have a similar system where permanent people were employed to promote continuing professional growth for their teachers from the province that they call prefectures, districts up to the school level. Therefore, when they discovered that this country had a similar system they agreed to support the Government of the Republic of Zambia. Moreover, they have not been disappointed since. (MOE1)

The role of the officers responsible for continuing professional development (CPD) at the Ministry Headquarters was to oversee lesson study and other CPD activities in provinces, districts, and schools. Under SPRINT, people who ran the In-service Unit were employed on a permanent basis (MOE & JICA, 2010b). According to MOE1, this had attracted attention from other Africa countries that wanted to learn more about the CPD system in Zambia. He stated that:

We have received a representative from Malawi, from Senegal, name it. Moreover, even Kenyans, although they were said to be the pioneers of some of these activities of JICA. Even Kenyans come to Zambia to learn because they do not have structures where people were employed permanently to spearhead school-based CPD. (MOE1)

Regarding SPRINT, ISP2 and ISP3 said that Educating Our Future: National Policy on Education (MOE, 1996) included strategies that the Ministry would use to support SPRINT. These strategies included: monitoring SPRINT activities, budgetting and timetabling SPRINT activities, and providing materials and conducting meetings with school management.
Educating Our Future has a chapter describing the functions of the In-service Unit at the Ministry Headquarters, the Resource Centres in provinces and districts, and the School In-service providers.

Ministry expectations

Regarding Educating Our Future, MOE1 said that the national policy on education, guided the implementation of continuing professional development in Zambia. He stated that:

The main policy for the Ministry of Education, pages 115 and 116, has main chapters that actually address continuing professional development. And that was the basis actually for the establishment of the In-service Unit at the national level, at the provincial level and district level. (MOE1)

The Implementation Guidelines, according to MOE 2 was a manual prescribing the eight steps of the lesson study cycle. MOE2 also noted the Implementation Guidelines urged all teachers to participate in lesson study. He explained the importance of teacher participation in lesson study, stating that:

With the coming in of the Teacher Accreditation Board, there was a proposal that for a teacher to be registered, they should have done a minimum number of hours for CPD. We hope it will be an aspect of teacher registration in which case we will be moving in a positive direction. (MOE2)

In a similar vein, ISP2, ISP5 and ISP6 noted that the Ministry had prescribed the lesson study cycle, and the number of lesson study cycles that schools should conduct each school term. According to ISP2, the standard was three lesson study cycles during Term 1, three cycles in Term 2 and one cycle in Term 3. ISP5 stated that “The actual lesson study cycle was the standard set for lesson study. The District Office enforced that standard”, while ISP6 said that schools were required to conduct three lesson study cycles in a school term, and follow the prescribed eight steps of lesson study. According to ISP2 and ISP5, teachers had no excuse for not conducting lesson study, with ISP5 stating that if the Ministry had let schools decide whether, when, and how many times they should conduct lesson study, very few schools would conduct lesson study at all.

According to ISP1, another Ministry expectation that was seen as supporting teachers
to conduct lesson study was the benchmark that over 50% of students who were exposed to lesson study should pass the subject at national examinations. ISP1 added that the benchmark was a challenge for teachers to meet, so it motivated them to conduct lesson study.

Furthermore, ISP1 stated that directive by the Ministry that teachers were not allowed to participate in lesson study in another school department helped teachers to implement lesson study effectively:

Teachers for business studies, for example, were not allowed to mix with teachers for languages because there would be a conflict of understanding and ideas. Equally, teachers for lower grades should not mix with teachers for upper grades. The rationale was to promote professionalism and quality provision of education and not to undermine anybody. (ISP1)

**Monitoring lesson study in schools**

Some in-service providers regarded monitoring as one of the significant lesson study support mechanisms. ISP3 said that the Standards and Teacher Education Department of the Ministry were responsible for lesson study monitoring, and that the Ministry had trained people at each school to monitor lesson study activities. Further, each school had a School In-service Co-ordinator (SIC), and an organization called the School Education Support Team (SEST). Lesson study monitoring was implemented by the Standards and Teacher Education Department, with the department requiring the District Standards Officers not only to monitor lesson study but also to plan different activities to induct teachers into the lesson study requirements. ISP3 said that the Ministry required the District Resource Centre Co-ordinator to monitor lesson study at the District level. This was echoed by comments made by two Standards Officers with whom I had informal conversations.

The senior Ministry officers also described the monitoring of lesson study as one of the standards put in place to ensure that schools were implementing lesson study according to the prescriptions in the *Implementation Guidelines* and the *Teaching Skills Book*, with MOE1 stating that “However, occasionally, ourselves, as the national level, we also go to sample to see if indeed what the districts were telling us was happening”.

MOE1 further stated that the Ministry collected data periodically from schools to determine the effectiveness of lesson study. The Ministry headquarters had developed tools
(forms) for monitoring lesson study and distributed them to resource centres and the education officers in charge of CPD.

We have monitoring tools. In fact, just a few weeks we finished analysing the data collected among schools to find out the effectiveness of the activities we have been doing. So, we have tools which we send to the provinces through the resource centre and the education officers in charge of continuing professional development where they collect data for us to check the effectiveness of the services of the activities we are doing there and the quality, and if quality issues are addressed in schools… by teachers as they do Lesson Study activities. (MOE1)

MOE1 added that the monitoring tools had been sent to the provinces through the Resource Centres and the Education Officers in charge of CPD activities and were part of the mechanisms the Ministry had put in place to measure the quality of lesson study activities.

Once in a while we find out that there's an improvement in learning and teaching by teachers using those same tools. Sometimes, in some areas, we find out that there's a lagging behind where teachers actually go down in terms of performance and learners. (MOE1)

In addition, Ministry headquarters monitored lesson study using the reports from provinces and districts. MOE1 said that reports were the basis for monitoring lesson study activities, emphasising that the reports for each teacher group were used as the evidence of lesson study implementation. Further, MOE2 stated that the reports were the basis for addressing the challenges teachers encountered when implementing lesson study.

When we come together, usually, there is the issue of reporting… [From the reports] we look at what impact they [lesson study cycles] had what challenges they [schools] had and then try to see how we can go round those challenges through those reports that we get. (MOE2)

ISP4 added that the Ministry had trained the people shown in Figure 5.3 at each school to spearhead the CPD activities at the school level and monitor lesson study using the prescribed tools (forms).
Regarding in-service providers actually monitoring lesson study, ISP4 said he monitored lesson study; participated in lesson study activities; and talked to Head Teachers about the implementation of lesson study during school senior management meetings.

Similarly, ISP6 reported that:

We monitor the undertakings of lesson study cycles in schools by getting to the schools and being part of the lesson study cycles. That was one of the ways that we support them, so that where they think they were lagging behind or they were not clear or there were questions, answers can be given. There was also an aspect of them reporting it was not an aspect of daily reporting or weekly reporting; but at the end of the term, they have to generate reports of the undertakings that they have done in terms of lesson study and we look at those reports and verify them and put them together to come up with our District reports. (ISP6)

ISP3 spoke about her experience of lesson study monitoring as follows:

We monitor the implementation of CPDs in schools. We go and check even in the books, how the records were being kept, and how much money had been spent. Was it planned for? If so, can we see the work plan? You get in a school and you look at the activity-based budget of the school and the annual work plan. They must be able
Meetings between Ministry Officers and school administrators were considered necessary. MOE2, for example, explained that Ministry officials held meetings with schools to learn more about how schools were implementing lesson study, to exchange ideas, to advise schools where and how they could do better, and to learn more about the challenges schools faced.

Another form of support given by the in-service providers was the actual services provided during lesson study. ISP4 explained her role in maintaining the standards and the quality of lesson study. She said that she ensured schools were not merely conducting routine lesson study cycles, but were also selecting new challenging topics. She also said she ensured the findings of the lesson study were treasured and kept, stating that:

Lesson study is research in its own right. We have invested time and resources. So, they must document. The standard is that I want to see documents for lesson study. When I go to the School, I ask for the work-plan for their lesson study activities and the updated records. (ISP4)

ISP4 added that teacher promotion was linked to their professional commitment to lesson study, as well as academic qualifications and other factors. Furthermore, she claimed to be a model for the teachers:

I put in my effort and I have provided a standard benchmark for the schools because they see how passionately I speak about lesson study and how knowledgeable I am. I am concerned about the professional growth of the teacher. If they were not involved then they were not growing professionally. And if they were not growing professionally, they were not making improvements to the teaching and learning. (ISP4)

**Budgetary allocation for lesson study**

As noted by MOE1, there was no specified budget for mathematics. However, there was a budget line for CPD at national, provincial, district, and school levels. However, he noted that allocated funds were not adequate, “but at least there was a budget line, reflected
specifically as a support to CPD for teachers”. Similarly, MOE2 said the budgetary allocation for CPD activities was not enough, concluding that:

Maybe that is the reason why we insist on school-based rather than the other cascade system, because people will have to move to be trained and that was a cost. We do not have that kind of money. So that was why we were trying to insist on the school-based CPD. (MOE2)

Further, MOE 2 noted that lesson study funding was through the school budget: “As a school, we do have it, because it is on the school calendar. It is an activity, which is funded”.

The in-service providers stated that budgeting for lesson study was necessary, with ISP4 stating that he ensured there was a commitment to lesson study and told school managements to budget for lesson study because schools needed materials, such as teaching aids, to implement lesson study. Similarly, ISP2 explained that, because lesson study was timetabled, it was included in the budget for refreshments and any other logistical needs. ISP3 stated “You get in a school and you look at the activity-based budget of the school and the annual work plan”.

Providing teaching materials to schools by the Ministry was one of the mechanisms for supporting lesson study. MOE2 stated, “We come up with resource materials that we feel can help in their lesson study at that level. For example, this booklet was produced for that purpose”, while ISP3 explained that the introduction of lesson study required a change in teaching and the introduction of relevant teaching and learning material.

However, ISP6 stated that finances were usually insufficient to secure adequate materials that schools needed to implement lesson study. He added “If it were possible with finances the provision of concrete materials at large should be promoted”.

Similarly, ISP3 noted that the in-service providers sometimes were unable to provide the resources to schools to procure the materials for lesson study. He added that many schools used their parent involvement policy and the provisions of the Public-Private Partnership Act of 2009 of the laws of Zambia to invite the public to participate and help them with the materials.

ISP4 also stated that CPD funds from the Ministry Headquarters were not released at appropriate times and were sometimes inadequate to meet the CPD needs. ISP6 observed that a small amount of money was allocated toward the purchasing of teaching and learning aids or
materials. He stated that:

At the district level, it is a bit difficult to make budgets for the school. However, if we make a request to say we have a programme or training to undertake there was always a component in the District Resource Centre account to enable us to undertake these programmes. (ISP6)

At the District level efforts had been made to allocate funds for lesson study in mathematics. ISP3 said that there was a budgetary allocation for lesson study in mathematics and for the activities of Standard Officers and the District Resource Centre Co-ordinators.

**The new curriculum**

The new curriculum was an agenda item in Facilitators’ and Stakeholders’ Workshops. MOE1 stated that lesson study, or a school-based structure was used to re-orient teachers to new mathematics topics that had been included in the revised curriculum. The teacher group meetings had been the fora through which teachers had been educated about these new curriculum items and were also used to develop teachers’ skills to enable them to handle these new mathematics topics.

Further, MOE1 explained that week-long Stakeholders’ Workshops and Facilitators’ Workshops were held during school holidays. Head Teachers, Senior Teachers, Deputy Head Teachers, HODs, attended the Stakeholders’ Workshops, where new interventions from the Ministry of Education were discussed. Facilitators’ Workshops, held at provincial or district levels, aimed to retrain teachers in the new mathematics topics in the revised curriculum. Because one week was not enough for teachers to master these, Facilitators’ Workshops were repeated every term.

MOE2 observed that although the new curriculum did not mention lesson study, it contained principles requiring teachers to engage in lesson study. Besides, the Ministry wanted lesson study as one of the means for implementing the new curriculum.

ISP2 stated that all the topics for lesson study in schools came from the new curriculum because the *Implementation Guidelines* required teachers to pick challenging topics for lesson study, and the new curriculum contained challenging topics. Similarly, ISP6 noted that the new curriculum required teachers to use new methods of teaching. He said the revised curriculum
supported lesson study because it ushered in a structure for helping teachers use new methods. He added that schools were using the new curriculum.

However, ISP3 said that those conducting lesson study should ensure that what was stated in the curriculum was taught effectively. He added that lesson study was an appropriate method that teachers could use to handle the topics in the new curriculum. Further, ISP3 claimed the introduction of the new curriculum supported lesson study because that the Ministry envisaged the new curriculum being implemented through SBCPD and lesson study is an SBCPD approach. He stated, “The implementation of the new curriculum demands more of teaching and training of teachers” (ISP3).

**Timetabling lesson study**

According to the in-service providers, lesson study was supported at school level through timetabling within the school plan. ISP2 stated that timetabling lesson study was a typical mechanism her department had implemented to support lesson study in schools. She added that timetabling lesson study on the school plan helped the school administrators to budget for lesson study:

> Because it is timetabled … it is included in the budget, to say. During that day, at least they will be refreshments and any other logistical support. Paper will be available, the forms which will be used by observers will be able to be printed. (ISP2)

ISP4 stated that lesson Study activities were now part of the school timetable. She said timetabling lesson study helped the teachers to plan the class activities their student would do when teachers are attending lesson study. She stated, “They shouldn’t leave students without work to be done. They leave them with work to be done. Like the period when the students are gone to the library, then the teacher also attends to the CPD activities”.

Similarly, ISP6 stated that timetabling of lesson study should ensure that the classes whose teachers were attending lesson study were left with student activities. He stated that:

> There is also a problem of timing on the timetable because we are also strict that learners must have their time to learn. But this should also be structured such that when it happens, it gives less destruction or less distortion to the learning of the students. So sometimes, it is really a challenge to find out what is the appropriate
time. You know that is a challenge on its own. And sometimes you have to do that, *conduct lesson study* [emphasis added], outside teaching time you know. (ISP6)

**Challenges in supporting lesson study**

Among the challenges faced by in-service providers in supporting lesson study were insufficient funds, the late release of funds for monitoring lesson study activities, an inadequate workforce, and not being directly responsible for monitoring lesson study at the school level.

MOE1 stated that insufficient funds and delays in the release of funds were one of the challenges officers faced. He said that the delays in the disbursement of funds affected the timely support of lesson study activities and sometimes led to the postponement of lesson study monitoring activities for a month or two.

The funding mechanisms of the provincial and district resource centres also posed a challenge. They did not have funds readily available because of the bureaucracy involved in accessing funds from the office of the District Education Board Secretary or the Provincial Education Officer.

If the Ministry could place, maybe, an accountant at this place [resource centre] because they are stand-alone structures which the government has built. If may be an accountant could be attached to those institutions and then they are funded directly… Currently, they rely on the accounting staff at District Education Board Secretary's Office or at Provincial Education Officer's office. And sometimes delays in the release of funds or funds to the co-ordinators to go in the schools and support the teachers. (MOE1)

ISP4 said the funds and transport were not sufficient to allow officers to monitor lesson study activities in all schools. Insufficient funds, according to ISP3, resulted in non-procurement of the essential teaching materials. He added that the Parent Teachers Association had been supporting officers with transport. He further added that the Ministry had invited the public to participate and help with the needed resources. Since officers could not monitor lesson study in all schools, ISP6 explained officers relied on reports from schools.

Concerning the inadequate workforce, ISP1 said there were few Standard Officers to inspect lesson study in all schools. In addition, ISP5 stated that it was difficult replacing retired CPD Co-ordinators, and re-training was needed. Concerning funding and teaching materials,
ISP6 said improved funding and provision of teaching materials should have been promoted.

Another challenge Ministry officers faced in supporting lesson study was that it was difficult to establish if the lesson study groups were investigating the materials provided by the Ministry.

We are not directly responsible for lesson study. Sometimes you can take these materials to the teachers, and depending on the supervision at local level, they may not be used. So, meaning the impact will not be felt, as we would want it to be.

(MOE2)

Because the Ministry Officers did not directly supervise lesson study implementation, ISP6 was worried that “sometimes you can take these materials to the teachers and depending on the supervision at the local level they may not be used”.

According to ISP2, facilitators and not Ministry Officers should have been monitoring the lesson study. She said that instead of having one officer from the Ministry struggle to monitor lesson study in all schools, facilitators should monitor. She added that schools rarely invited Ministry Officers to help them with lesson study, and that all the school calendars should be synchronized with the Ministry calendars to allow Ministry Officers to attend lesson study more frequently.

5.2.2 In-service providers versus Ministry documents

The role of the in-service providers was to ensure that what was written was implemented. Therefore, most of the views they expressed were based on the Ministry documents.

The in-service providers viewed their role of monitoring lesson study implementation as a support mechanism. For example, MOE1 stated that monitoring was a support mechanism, which required more resources. He said, “Sometimes we are not able to monitor and particularly give support to our provinces and districts because we don’t have resources for us to procure fuel and travel those provinces”. Similarly, MOE2 stated that the Ministry had appointed Standards Officers to monitor lesson study among other activities. He said, “We have our Standard Officers, and these Standard Officers are our link”. However, this did not come through clearly from the documents.
The Implementation Guidelines had provided the timetable for lesson study cycles that schools should conduct. The in-service providers stated that lesson study was supported at school level through timetabling within the school plan, stating that timetabling helped school administrators to budget for lesson study.

The Implementation Guidelines stated that the CPD activities were included in the annual work plan and budgets. It also stated that those planning lesson study related workshops (that is, the Facilitators’ and Stakeholders’ Workshops) should plan the budget and procurement of materials. The in-services providers stated that the budgetary allocation was necessary for supporting lesson study. They were of the view that budgets for lesson study should stand alone instead of being embedded in the CPD budget. They also stated that adequate funds should be allocated for supporting lesson study, and that such funds should be disbursed on time.

5.3 School administrators’ views on lesson study support

At each of the three case schools, interviews were conducted with the head teacher (referred to here as HTA, HTB, HTC), and the CPD co-ordinator (referred to here as CA and CC). School B had no CPD co-ordinator during the data collection period of this study. The CPD co-co-ordinator was on leave and there was no-one appointed to replace him, with the Deputy Headteacher standing in for him from time to time.

5.3.1 School administrators’ interview responses

This section focusses on views of the school administrators regarding the mechanisms put in place to support the implementation of lesson study.

Support mechanisms implemented at school level

The school administrators were asked to describe the typical strategies the school and the mathematics department in particular had implemented or intended to implement to support lesson study at the school.

According to CA, teamwork had resulted in uniform lesson plans, common skills among teachers, and uniform sequencing of the topics to be taught. As a result, no one would be left out during examinations or tests because teachers covered the same type of work.
Lesson study attendance forms had been introduced in schools to foster teachers’ participation. CC said the form required teachers to fill in what they had learnt and challenges faced. The forms were put on individual files and submitted for checking by the Heads of Department. Based on the challenges stated on the forms, the School Administrators and the teachers sat down together and planned the way forward.

Lesson study was timetabled in school plans, with certain days of a term committed to lesson study. HTA explained that the CPD Co-ordinator at school level did the whole plan for the term. He added, “They will simply do a budget, submit, I approve, and the activity will be done”.

Responses to the question regarding the extent and evidence of the importance of lesson study in school planning varied among the school administrators and yielded two themes: lesson study appeared in the school or department term plans with associated budgets; and lesson study was carefully timetabled with due consideration to dates for other school activities directed by school administration and the District Office of Headquarters.

According to CA, lessons study cycles were planned, with an associated budget indicated.

The school is part of the District, the Province and the Nation. The District, the Province and the Nation have other programs they want the school to implement. Therefore, we would want our plans for lesson study to fit well in those programmes. Therefore, as we plan we would know that on this date there is a certain programme. We ensure there is no collision because we want to finish our programmes or implement our CPD program without the interference of external activities. (CC)

The above explanation echoed the explanation of HTB that before the term commenced the School Management sat down and looked at the CPD activities outlined by each department. The Management finalised the School Plan, indicating when each department was going to conduct each activity and who was going to facilitate.

Teachers participating in lesson study at other schools

The school administrators were asked to state the type of support given to teachers participating in lesson study at other schools in the district. School administrators supported
teachers participating in lesson study by providing required funds, transport, and equipment for making presentations. CA added that teachers were provided with projectors for making their presentations. Similarly, CC said teachers were being supported financially in terms of their daily subsistence allowance and transport money. HTB explained as follows.

There are times when our teachers have been invited. In fact, I was just looking at one letter when one of our teachers was invited to go and facilitate at one of our sister schools. We provided the teacher with all the logistical needs. (HTB)

**Monitoring lesson study in schools**

School administrators said they participated in lesson study. According to HTA, he joined the lesson study team to see what they were doing. When out of town, or school, his deputy attended the lesson study. HTB said the School Inset Co-ordinator (SIC) was directly in charge of CPD at his school. Therefore, the SIC was actually supposed to attended lesson study for every department and prepare a report. He added he would also attend the lesson study sessions, provided he was not busy.

If a department missed any lesson study sessions, the sessions had to be rescheduled. CA explained he had a calendar for lesson study and ensured every department in the school implemented lesson study. If not, he questioned the Head of Department to give reasons as to why they had not implemented lesson study, and asked the department to reschedule the activity.

Both HTA and HTB said they demanded reports from every department to verify what had happened. HTB added that “Even though I may pass to see what is happening, I have told them to write reports for every activity that they undertake”.

The School Administrators said they used the findings from monitoring to help them identify the gaps that needed to be addressed. CA said monitoring results helped identify gaps in planned activities. For example, the results might show that it was impossible to conduct three lesson study cycles when the term included an examination. Similarly, CC gave an example where reports revealed that students failed to understand mathematics concepts during the research lesson. In such a case, teachers would sit down and find ways of approaching the topic.
**Challenges in supporting lesson study**

Financial constraints were raised as a challenge to the implementation of lesson study. HTA said funding was inadequate, but added that increasing the budgetary allocation for lesson study from within the school budget would strain the school budget.

Another concern was that teachers who were supposed to attend lesson study attended other school activities instead.

[On] the actual date the teacher will be too busy and would even attend other workshops outside the school. Meanwhile, that was the key person for lesson study. As result, we would fail to implement that lesson study on the actual day that was planned. It brings a lot of re-scheduling [of] the activities. (CC)

According to CA, another concern was the low interest of teachers. He explained some that teachers thought they knew all the mathematics because of the training they had received at college. He added that those teaching students who had very good results thought it was a waste of time participating in lesson study.

**What could be done differently**

The school administrators stated that involving students in evaluating a research lesson was a requirement stated in the *Implementation Guidelines*. Specifically, students were required to complete the *Monitoring & Evaluation Format 03B* after each research lesson (MOE, 2010b, p 61). One school administrator, CA, expressed his worry that “Students were not involved in evaluating the lessons”.

There was an option of implementing lesson study in the afternoon when students were in prep (time for studying and writing homework). The reason for conducting lesson study during prep was explained by CC as follows:

There are certain groups that are too big and when we are doing the CPD it will mean all the teachers will have to leave their classes and attend one class where they will be having a demo lesson or a revised lesson. Therefore, what we have done is our CPD implementation will be done after the ninth period in our school timetable. That will be after 14:40 because children have what we call active prep from 14:40 to 16:00. That is what [we are] doing this term and I think we are doing fine. (CC)
In the example below, the Head Teacher at school B indicated that increasing the budgetary allocation could support lesson study. HTB stated, “Lesson study is an academic program that needs to be prioritised and more funds allocated. I believe that increased funding would enable teachers to conduct lesson study more than three times in a term”.

5.3.2 School administrators versus in-service providers

Perspectives of the in-service providers and the school administrators regarding the mechanisms used to support lesson study were similar. However, a point that emerged through the interviews with school administrators was that a lesson study group that missed a lesson study session had to reschedule it. The Ministry had standardised lesson study monitoring through checklists (see MOE & JICA, 2010b) and these checklists helped those monitoring lesson study to extract information, such as the number of lesson study cycles completed, the number of people who attended, the topic, and the response and reactions of the observers. The justification for school level monitoring was that Standards Officers could not afford to be in every school in the district with the limitations of transport and staff. Therefore, instead of playing the role as supporter, head teachers were authorised to monitor lesson study activities using the Heads of Departments and the mechanisms within the schools.

5.4 Mathematics teachers’ views on lesson study support

At each of the three case schools, interviews were conducted with the two teachers who taught the research lessons (hereafter referred to as TA1, TA2, TB1, TB2, TC1, and TC2).

5.4.1 Mathematics teachers’ interview responses

This section focusses on the views of teachers regarding the mechanisms put in place to support the implementation of lesson study.

The school environment

The teachers were asked what they saw as the critical elements of the school environment for supporting lesson study.

According to TA2, using the Implementation Guidelines and the Teaching Skills Book
was important because these were the policy documents that supported lesson study. He added that, although the *Implementation Guidelines* urged school administrators to participate in lesson study, school administrators rarely participated in lesson study, which he considered a serious omission.

As can be seen below, TC1, TA1 and TC2 all believed that using teaching and learning materials was necessary for supporting lesson study.

Teaching aids are in different categories. There are those that you can create as a teacher and there are those that you can just buy from other sources. However, so far, I have not seen any teaching aid that the school has bought. All the teaching aids that we use are just paperwork that we use and create a picture that will enable students to learn. (TC1)

Teachers need teaching aids to enable them to teach well and enable students to see a real-life situation in Mathematics. (TA1)

Teachers need other suitable teaching aids apart from charts, such as projectors. Certain subjects in the new curriculum have been introduced and schools are still waiting for textbooks to be printed. Teachers are still using the textbooks for the old curriculum. I think the Ministry should have produced the textbooks before implementing the new curriculum. (TC2)

According to TA1, the belief that teachers should complete the syllabus before students sit for their examinations resulted in little time left for lesson study. He stated:

The problem we have is that each time we do it in a hurry because we realise that the syllabus has many topics that we need to cover. We feel that we are losing time when we conduct lesson study. As a result, lesson study is not done properly or it is not done at all. (TB1)

Furthermore, TA1 stated that English, being the only language of instruction in Zambian schools, had negative effects on lesson study. He said some students did not understand English well, or could not speak it well. He concluded that language was often a barrier to effective communication.

Teachers viewed the Ministry policy on CPD as supporting lesson study in schools. This view is in line with the reasons that the Ministry published the *Implementation Guidelines*,
the *Teaching Skills Book* and the *Management Skills Book*. These publications guided the implementation of lesson study and stated the roles and responsibilities of participants in lesson study.

**The school curriculum**

Teachers were asked to state the ways in which the new school curriculum (MESVTEE, 2013) supported lesson study.

According to TA2, schools were using lesson study to implement the new curriculum. He said that the new curriculum had some topics that some teachers considered difficult, and therefore suitable for lesson study. According to TB1, more topics were introduced in the new curriculum. However, the time frame to complete the syllabus had not been increased. He noted further that the new curriculum was much easier to understand and could be implemented easily using lesson study.

TC1 said that the new curriculum supported lesson study because it tried to involve all learners and teachers working together. She added that the National Policy on Education, *Educating Our Future* (MOE, 1996) emphasized that teachers should work in groups and discuss the challenges they faced.

**Challenges in supporting lesson study**

One teacher, TA2, said that the Ministry had imposed lesson study on teachers and assured them that it would succeed because it had succeeded in other African countries, such as Kenya and Cameroon. He pointed out that the Ministry had paid little attention to the factors that might have contributed to success in other African countries. He concluded that conditions such as a good classroom environment and adequate materials were necessary for lesson study to work in Zambia.

Furthermore, he questioned the idea of using a research lesson plan written for one class in another class. He reasoned that, while lesson plans were generic, a lesson plan written for one particular class might have been tailored to address the problems remote to that particular class.
5.4.2 Mathematics teachers versus school administrators

The mathematics teachers interviewed considered the participation of school administrators as a lesson study support mechanism. However, they said that school administrators rarely participated in lesson study, which they considered a serious omission. The school administrators, on the other hand, stated that they supported lesson study through monitoring. However, the monitoring usually involved the administrators checking lesson study reports from the teachers, instead of attending the lesson study sessions. HTA, for example, stated that the School In-service Co-ordinator should attend the lesson study sessions and thereafter prepare and submit the report to the school administrators.

The challenges in supporting lesson study were perceived differently by the teachers and the school administrators. According to the school administrators, challenges included financial constraints, teachers who were supposed to attend lesson study attending other school activities instead, and teachers with a low interest in lesson study – with some of these teachers thinking that they knew all about mathematics because of the training they had received at college. According to the teachers, challenges included a lack of a good classroom environment and adequate materials that were needed for lesson study to work in Zambia, and the fact that a lesson plan written for one particular class might not address the problems faced by another class.

5.5 Conclusion

At the Ministry level, the Implementation Guidelines and the Teaching Skill Book were regarded not just as policy documents but also as mechanisms to support the implementation of lesson study, a view which was endorsed by in-service providers and teachers, although much of the support referred to related to the effect of mandating the implementation of lesson study.

A wide range of challenges in implementing lesson study were anticipated in the Implementation Guidelines. These included: low commitment by school management to professional development of teachers; inadequate time for implementing lesson study; difficulties due to geographical location of schools; negative attitudes among some teachers; insufficient skills of teachers; inadequate materials; and the limited number of qualified teachers.
of science and mathematics in schools.

Proposed counter-measures to address these anticipated challenges covered a wide spectrum – for example, inculcating a culture of teachers working for 8 hours a day, considering procuring bicycles to assist teachers to move within clusters, making teachers understand and appreciate the benefits of professional development, conducting on-going training workshops for facilitators, and making improvised teaching materials with locally available resources, to mention just a few of those proposed.

The Master Plan highlighted key strategies, based on the experience gained in three pilot provinces, for rolling out lesson study nationwide. These included the involvement of Ministry Officers, as well as provincial and district education support teams, with Stakeholders’ and Facilitators’ workshops conducted in each province.

The Ministry Officers and other in-service providers interviewed identified the SPRINT programme as a framework for supporting lesson study implementation. While some interviewees said that they held meetings at schools and took part in the lesson study cycles, their focus appeared to be mainly on monitoring school records relating to the implementation of lesson study, with Ministry headquarters monitoring lesson study using a chain of reports provided in turn by schools, districts and provinces. Among the challenges identified by these interviewees was a lack of adequate funding and funds not being available at the times when they were needed. Finances were also insufficient to secure adequate materials that schools needed to implement lesson study. Other challenges identified included the lack of sufficient officers to monitor lesson study in all schools, as well as the fact that schools rarely invited Ministry Officers to help them with lesson study.

The new curriculum was identified by Ministry Officers and other in-service providers as supporting lesson study by promoting principles that resonated with lesson study and by containing topics that teachers found challenging, which was a criterion for selecting topics for lesson study. According to in-service providers, the Stakeholders’ and Facilitators’ workshops, which were repeated each term, retrained teachers in the new mathematics topics in the revised curriculum, while lesson study assisted in the successful transition to the new curriculum.

According to the school administrators who were interviewed, lesson study was supported through the timetabling of lesson study activities, which were monitored through the provision of written reports. School administrators also said that they participated in lesson
study, a claim that was disputed by at least one teacher, who regarded this as a serious omission.

Administrators also said that teachers participating in lesson study were supported with funding, transport, and equipment for making presentations. However financial constraints were raised as a challenge, with one Headteacher stating that funding was inadequate. another concern was the low interest of teachers. Another concern that was raised was a lack of interest in lesson study with some teachers believing they knew all they needed to know from college, while others who had very good results thought it was a waste of time.

As well as the teachers’ comments mentioned above, other issues raised by the teachers interviewed included the effect of English being the only language of instruction in Zambian schools, the lack of time due to needing to complete the syllabus, and the lack of suitable teaching aids other than charts and other “home-made” aids (such as projectors), with even the textbooks to support the new syllabus not yet being available.
Chapter 6 Implementation of lesson study at school level

While lesson study remains a voluntary activity in many countries, Zambia has a policy that requires every government primary and secondary school to implement lesson study in every subject area.

This chapter addresses research question SQ3: How is lesson study being implemented at the school level?

The Zambian lesson study cycle is outlined in Chapter 4 of this thesis, based on Ministry publications, specifically the Implementation Guidelines (MOE & JICA, 2010b) and the Teaching Skills Book (MOE & JICA, 2009).

Three schools, Schools A, B and C, participated in this part of the research. As stated in Chapter 3 of this thesis, the selection of schools that participated in this study was based on the criteria that they would enrich the findings. Schools A, B and C were also invited to participate in this study because they were easily accessible; communication with the teachers and school administrators through emails and phones was guaranteed; their mathematics departments were adequately staffed; and they had adequate instructional materials.

The researcher met the headteacher, the head of the mathematics department (HOD) and the co-ordinator for continuing professional development (CPD) at each case school to make arrangements for conducting interviews and observing two lesson study cycles at each school. The schools provided suitable dates from the school calendar, with the HOD at School A explaining that these dates could not be changed to facilitate lesson observation by the researcher. In the case of School C, the headteacher asked if the researcher was going to observe all the stages of each lesson study cycle: planning the research lesson; teaching the research lesson; revising the lesson; the same teacher teaching the revised lesson to a different class; and the post-lesson discussion. The researcher confirmed that she would observe, and video record all stages of each lesson study cycle.

The video data from the six lesson study cycles were analyzed using Transana software.

This chapter briefly discusses the school environment in Zambia and the provides details of each of the lesson study cycles at each of the three case study schools.
6.1 The school environment in Zambia

Zambia adopted lesson study in 2005 with the help of the Japanese International Cooperation Agency (JICA). The adoption followed the introduction of free basic education (Grades 1 to 9) in 2002, through the Basic Educational Sub-Sector Investment Programme. Introduction of the free basic education policy in 2002 brought about not only the increase of the enrolment from Grade 1 to Grade 7, but also significant increases in gross enrolment rates and net enrolment rates in the entire basic education sector (JICA, 2011). Enrolment in the basic education stage increased by 40%, from 2.5 million in 2004 to 3.5 million in 2010 (JICA, 2012). In addition, the total number of basic schools (Grades 1 to 9) increased by an average rate of 4.8% annually from 5,324 in 2000 to 8,493 in 2010 (JICA, 2012).

Student-teacher ratios vary across Zambia, with the Copperbelt Province having the ratio of 44:1 in 2013, and Luapula Province 92:1 (MESVTEE, 2014). Intuitively, lesson study groups on Copperbelt Province would face fewer challenges than those faced by their colleagues in Luapula Province. Furthermore, as noted in the Implementation Guidelines (MOE & JICA, 2010b), many schools face a shortage of qualified science or mathematics teachers.

Further, the Ministry stated that there was a low commitment of school management to continuing professional development (CPD) programmes. To counter this, the Ministry produced the Management Skills Book (MOE & JICA, 2010a) to help school managers develop skills for managing CPD effectively. The 2008 report on primary education in Zambia by the Ministry of Foreign Affairs of the Netherlands (Policy and Operations Evaluation Department, IOB) stated that:

Effective school management can make the difference. A head teacher with well-developed management skills, supported by an effective district manager and inspectorate, creates a stimulating learning environment, holds the teachers accountable and reduces teacher and pupil absenteeism. (IOB, 2008, p. 16)

The Ministry was also sceptical that teachers were using instructional materials effectively in some of the schools that had adequate materials. The IOB report concluded that, in Zambian schools, “books are generally used ineffectively. Teacher training needs to be improved in order to ensure effective teaching and the effective use of books” (IOB, 2008, p. 17).
6.2 School A: Lesson study cycles 1 and 2

Located in the Southern Province of Zambia, about three kilometres from the city centre, School A is a co-educational boarding school with about 1500 on-campus students in Years 8 to 12. A prestigious school, drawing high-performing students from all over the country, School A is esteemed by the Zambian community, and enjoys relatively good funding from the Ministry of Education. Lesson study was first introduced at School A in 2012 as part of the expansion of lesson study to all ten provinces in Zambia.

The School was headed by a mathematics teacher. He was trained in lesson study in Japan, as well as in Kenya and Malaysia by Japanese experts. He also attended many lesson study training workshops in Zambia. The Ministry used him for disseminating information about lesson study to teachers in workshops held within the school district. In this vein, the mathematics teachers at School A could learn about lesson study from him, as he was well placed to correct the misconceptions teachers might have about lesson study.

Unlike some secondary schools, School A employed trained teachers, mostly those with undergraduate degrees. The School Mathematics Department was relatively well staffed, with a mean years of teaching mathematics at School of 6 years. Furthermore, the Headteacher stated that School A had implemented a programme with the University of Zambia to upgrade teachers with Diploma in Secondary Education (Mathematics) to Bachelor of Education (Mathematics).

To retain mathematics teachers, the school accommodated the teachers at the School Estates located within the School Campus. In addition, the School gave rental money to those it could not accommodate.

The average student-teacher ratio for mathematics classes that participated in this study was 30:1, much lower than the 2013 national average of 56:1 (MOE, 2014). School A also had relatively good facilities such as chalkboards and relatively adequate instructional materials, such as student text books. The Teacher District Resource Centre, stocked with instructional materials, was located within School A campus, allowing the teachers ease of access to the materials.

School A had two streams of students, namely the morning and the afternoon (APU) stream. The morning stream referred to the core students of School A, comprising high performing students enrolled from all over the nation. These students were boarders. The APU
stream comprised students enrolled from the school district based on their ability to pay the school fees and not their academic performance. The APU was administered by a Committee, comprising elected members from the school teachers. During the initial meeting between the researcher, the Headteacher and the HOD for mathematics, the Headteacher told the researcher that the APU had 350 students each year. APU had 10 classes – two classes for each grade (8-12). Not all teachers in the School were involved in teaching the APU classes. However, mathematics being a compulsory subject, nine out of 11 mathematics teachers were involved in teaching APU classes. The school fees paid were shared among those teaching APU. Notably, lesson study was administered to the morning stream and not the APU stream.

Lesson study was first introduced at School A in 2012. In the interviews, the Headteacher said that teachers implemented lesson study in mathematics according to the recommendations in the policy documents. He further said the school administrators (himself, the CPD Co-ordinator and the deputy headteacher) sometimes attended mathematics lesson study and gave guidance to the teachers. The CPD Co-ordinator said that the mathematics department was supposed to conduct one lesson study cycle each month. He added that because of the overload from the syllabus and teachers’ involvement in invigilating national examinations, teachers were now only required to conduct one lesson study in term 3. The biggest challenge both administrators mentioned was that teachers did not have enough time to conduct lesson study.

6.2.1 Lesson study cycle 1

The research lesson for cycle 1 took place in Grade 12, on the topic of “Statistics”, with sub-topic, “Collection and classification of data”.

The seven teachers completed cycle 1 on the same day. They planned, taught, reflected on the lesson and revised it in the morning. In the afternoon, the lesson was re-taught by the same teacher to a different class, which was part of the morning stream, as arranged by the HOD for the purpose of the lesson study. The HOD said that his team had to complete cycle 1 on the same day because the school timetable had set two days for the lesson study cycle. He stated that planning was supposed take place the work day before but did not happen because three teachers in his Department had attended school sports the previous day. He added that the Department could not postpone the lesson study cycle to a later day as this would affect other school activities in which his teachers were involved.
Statistics at Grade 11 was the 14th topic of the 16 topics in the New School Syllabus. Statistics at Grade 11 level had three sub-topics: Concept of statistics, Data presentation and Measures of central tendency. The outcomes were that students should appreciate the concepts of statistics; collect, classify, tabulate and interpret data; and calculate and interpret the mean, mode and median of grouped and ungrouped data. Therefore, at the end of the three subtopics students were expected to know how to classify and tabulate data (using pie charts, bar and compound bar charts, stem and leaf, histogram, line graphs, frequency tables and frequency polygons); differentiate between grouped and ungrouped data, to interpret data; to understand the mean, mode, median and assumed mean.

The planned lesson on “collection and classification of data” did not seem to fit the curriculum because the lesson repeated Grade 11 content in statistics. In Grade 12, statistics was the seventh topic of the eight topics. Statistics at Grade 12 had three sub-topics. The first sub-topic was Grouped and ungrouped data, whose outcome was for students to work with grouped and ungrouped data. The second topic was Cumulative frequency tables. Students were expected to draw cumulative frequency tables, curves, and relative cumulative curves. The last topic was Measures of dispersion. Students were expected to find quartiles, calculate the interquartile range, semi interquartile range, and percentiles. They were also expected to calculate variance and standard deviation for ungrouped and grouped data.

Planning research lesson 1

The planning session was held in the Mathematics Department office in the class period immediately preceding the research lesson. There were seven participants, comprising the Head of the Mathematics Department (HOD) and six of the eleven teachers from the same department. As can be seen in Figure 6.1, most members of the planning team were present throughout the meeting. According to the interviews with the Headteacher (HTA), one of the school administrators (either, the Headteacher, the Deputy Head, or the School CPD Coordinator) was expected to attend the session. However, they did not attend the session because they had to attend to other pressing school duties. The HOD chaired the session. The teacher who was to teach the research lesson, TA1, had already been chosen and was asked to complete the Lesson Plan Template during the meeting.
Figure 6.1. Transana Episodic Keyword Map Report for planning research lesson 1 at School A
The planning session, which had been planned to last 40 minutes, lasted about 34 minutes (see Figure 6.1), instead of two to three hours as recommended in the Implementation Guidelines. The session started 20 minutes late because some teachers were late. The planning was further interrupted when the HOD left the room to collect a proposed teaching aid from the School Clinic – the Under Five Card. The teachers had to wait for him to come back because he was chairing the session. As a result, the planning session overlapped with the class time allocated for the research lesson by 12 minutes.

Lesson goals

The HOD stated that statistics was an ideal topic for lesson study because Grade 12 students with different school backgrounds posed a challenge for teaching the topic. He noted that statistics was a topic that students struggled with year after year. He stated that the challenge was how to introduce statistics to Grade 12 students bearing in mind that at Junior secondary (Grade 8-9) there were statistics and that students at School A came from different schools.

He said, “With this little time we have, we should prepare a 40-minute lesson on the collection and classification of information”. The teachers did not give their views on the topic introduced by the HOD. As recommended in the Teaching Skills Book, teachers should discuss and state the rationale, justifying the significance of the lesson. They should discuss exactly what is to be taught and learned in the lesson (content), outline why the lesson should be learned (educational value), discuss strategies for delivering the lesson; and discuss the location of the lesson in the unit on statistics.

The HOD then asked the team to consider students’ pre-requisite knowledge of statistics. The team identified three areas of student knowledge required for statistics: the number system, basic statistics, and angles. In the New School Syllabus, the number system was the first Unit in Grade 10, comprising the following topics: sets and logic, real numbers, common fractions, ordering, indices, squares and square roots, social and commercial arithmetic. Furthermore, the first sub-topic of the fourth Unit (Geometry) in Grade 10 was angles. In Grade 11, students had learned angles of a circle under the unit on circles.

The planning team reflected on the types of teaching aids to use in class,
and agreed to use the *Under Five Card* (weight and age chart), which was used by nurses to monitor the weight of young children (from birth to five years) to monitor if a child’s weight keeps within the normal weight for ages ranging from 0 to 2 – see Figure 6.2.

![Figure 6.2. Under Five Card for girls](image)

The HOD said that the teacher should use teaching aids (Under Five Cards for Boys and Girls, and the Tally Form for the diseases treated at the Clinic) to make pupils see and appreciate the real-life situation: why learn about statistics and where it is used.

The planning team formulated the objective for the lesson as:

*At the end of the lesson, pupils should be able to collect and classify information correctly, with pupils getting at least five out of six questions correct.*

Thereafter, the team discussed the activities for the lesson introduction, development, conclusion and evaluation.

**Lesson introduction**

As can be seen in Figure 6.1 discussion of the lesson introduction lasted 10 minutes. According to the lesson plan template, the team was supposed to state the teacher activities, student activities, and what students will learn from each activity (referred to as learning points on the lesson plan template, see column 4 in Figure 6.4).

The Chairperson told the team to state the actual question the teacher would pose in class to collect simple statistics from students. He said, “The teacher
can ask selected students to state the marks they obtained at term three test, for example”. The team agreed that TA1 would ask ten students to state the marks they got on the end of the 2014 Term 3 mathematics test, and six students to state their shoe sizes.

According to the *Teaching Skills Book*, this introductory question would not be considered as a pivotal question because pivotal questions should enable students to make predictions and engage in discussion before an activity. For example, a pivotal question could be framed like this: “What do you think is the best way to collect the marks students got on the end of term test, and what do you think is the best way to present these marks?” This question would require students to anticipate the methods for collecting and presenting information and frame their reasons for the methods they think are the best.

The team listed two student activities (“students respond” and “students give shoe sizes”), and the learning point “collection of data”. The team agreed that the teacher should use five minutes to introduce the lesson.

This lesson introduction, according to the *Teaching Skills Book*, was teacher-centred because students would not collect the data by themselves. Instead, they would observe the teacher collect data. The learning point (collection of data) implies that students would have a deeper understanding of how to collect data at the end of the lesson introduction.

**Lesson development**

Discussion of the lesson development lasted 10 minutes. The team discussed activities for the teacher and students, and the learning points for the students. The two teacher activities discussed were that TA1 should ask the students to present the marks stated on the chalkboard on a pie chart, and that TA1 should sum-up the students’ solutions and responses. The activity for the students was stated as “Students attempt the question”. Teachers did not discuss what exactly students should consider when drawing a pie chart. Furthermore, the learning point “data presentation” meant that students should have a deeper understanding of how to present data after the lesson development phase. However, the pie chart is not the only method for presenting data. The other methods (e.g., the bar chart and histogram) were not discussed by the teachers. The team agreed that TA1 should spend 10 minutes on the lesson development.
Lesson conclusion

The HOD told TA1 that he should say something after marking the evaluation exercise in class, unless marking would be done outside class time. He added that TA1 should invite some students to give their views on what they have learnt. Inviting students to give their views is in line with the recommendation in the *Teaching Skills Book* that students should be “encouraged to explain what they have learned and how it can be used in the future, perhaps in other lessons” (MOE & JICA, 2009, p. 16).

Lesson evaluation

The team spent five minutes discussing the lesson evaluation activities. The team agreed to evaluate the success of the lesson through discussion, and question and answer approaches. They agreed that TA1 should ask students to present the six shoe sizes on a pie chart. They stated the student activity as, “students attempt the question”. However, the lesson evaluation activities stated in the *Teaching Skills Book* go beyond giving students an exercise. The activities include teachers collecting and assessing student solutions; and asking students to comment on the entire lesson.

The final product was a two-page lesson plan shown in Figure 6.3, which stated the student task as presenting the data on a pie chart.

Finally, the HOD gave each team member a checklist for recording the observations, emphasising that each observer should take notes during the lesson. He said that the notes would be used to evaluate and revise the lesson. He also reminded the teachers to hurry up because the period for teaching the lesson had already started.
Teaching research lesson 1

The lesson was taught to a Grade 12 morning session class of 33 students. Only the seven teachers (including the HOD) who planned the lesson attended the lesson. As can be seen from Figure 6.4, the teaching session lasted 24 minutes instead of the planned 40 minutes as the team had used part of the class time to plan the lesson.

The lesson comprised the lesson introduction, lasting 5 minutes; the lesson development, lasting 15 minutes; and the lesson evaluation, lasting 4 minutes.
Figure 6.4. Transana Episodic Keyword Map Report for teaching research lesson 1 at School A
Lesson introduction

After writing the topic, Statistics, on the chalkboard, the teacher asked 10 students randomly to tell him the marks they got on the end of 2014 Term 3 mathematics test and he recorded the marks on the chalkboard shown in Figure 6.5. The marks were: 10, 20, 28, 23, 24, 20, 25, 18, 46, 28.

The teacher also chose six students randomly and asked them to state their shoes sizes. He wrote the following sizes on the board shown in Figure 6.4: 3, 5, 7, 3, 9, 8.

There was no explanation or discussion about the introduction of the topic of statistics.

![Image](image.png)

Figure 6.5. Marks for end of term test and shoes sizes

Lesson development

The teacher wrote the task for students to complete on the chalkboard as: *Present the above information (data) on the marks on a pie chart.* TA1 did not give students any hints as to how to calculate the angles of the pie chart. This task was based on the pre-requisite knowledge of the students about basic statistics, which as stated earlier was part of the Grade 11 curriculum.

As can be seen in Figure 6.4, the teacher spent four minutes walking between desks, checking and marking students’ work.
Later, the teacher asked for volunteers to draw the pie chart on the board. He stated that if there were no volunteers he would choose someone.

Figure 6.6. Students presenting their solutions to the class

Figure 6.6 shows two of the three students who had volunteered to present their solutions silently drawing their pie charts on the board.

While students were drawing their pie charts on the board, an observer was talking to the teacher, trying to go through the lesson plan (see Figure 6.7). The HOD also talked to the teacher, advising him to end the lesson when the time was up.

Figure 6.7. An observer talking to the teacher during the lesson

The teacher labelled the three pie charts drawn by students as A, B, and C (see, Figure 6.9). In pie chart A, the student had partitioned the pie chart into 11 slices with similar angle sizes. In B, the student had partitioned the chart into 10 slices, each slice having a different angle size, proportional to the actual exam mark instead of the frequency. In pie chart C, the student had partitioned the chart into 9 slices, taking into consideration the frequency of the marks by making the slice for 20, which occurred twice, approximately 40% of the pie.

The teacher asked the students who had drawn the pie charts look carefully at their pie charts made make corrections. The teachers asked the class to help their colleagues identify was
incorrect about each pie. One student answered that pie chart A because there were two angles, one with 4, and the other with 6, adding, “We don’t have marks for 4 and 6, it should be 46”. TA1 underlined the mark 46, which had been written with a slight separation between the 4 and the 6, on the board. Student A added a 6 to 4 to read as 46 but didn’t delete the slice labelled 6.

Another student told TA1 that pie chart C had a slice for 29, a mark not on the list of marks. TA1 acknowledged the comment by the student and asked the student who had drawn the pie chart C to replace 29 with 28. Instead the student drew a line to divide the slice into two and named one 28 and the other 29. Observing that the student had misunderstood the instruction, TA1 told the student that he was not asked to divide the slice into two, but to correct the mark 29 to 28. The student then erased the line he had drawn between the slices and wrote 28 as shown in Figure 6.8.

![Figure 6.8. Student changing the number 29 to 28 on pie chart C](image)

When asked to comment on which pie chart was correct, many students said C. One student said that he would not choose A because the angles sizes were almost the same despite that the size of the marks were different. Another student explained the difference between pie chart B and C, stating that the angle representing score 20 was the biggest in C because 20 was the most frequent score, and that the angle representing score 46 was the biggest in B because score 46 was the highest score in the given data. However, there was no further discussion on which pie chart, B or C, was correct.
Lesson evaluation

Immediately after the comments on the three pie charts, the teacher gave the students an evaluation exercise:

Present the above information (data) on the shoe sizes on a pie chart.

While the students completed the exercise, the teacher walked around the class, checking students’ work and marking their books (see Figure 6.10).
Lesson conclusion

The class period ended before the teacher had time to summarise the lesson, after the HOD reminded him to end the lesson as time was up. The teacher immediately reminded the students that they should complete the exercise in their own time and that the lesson came to an end.

Revising lesson 1

Immediately after the lesson the teachers met in the Mathematics Department office to reflect and revision the lesson. As can be seen from the top bar of Figure 6.11, the lesson revision session lasted 13 minutes. The seven teachers who had planned and attended the research lesson were present.

The HOD chaired the session. He commented that observers were expected to record their observations and recommendations during the lesson. However, throughout the lesson, all observers had remained seated, some in the front row and others in the back row of the classroom. The HOD took notes, but the other observers did not record their observations, despite having copies of the checklist for recording these.

The teacher who taught the lesson, TA1, was given a chance to speak first. He said that he was nervous during the first few minutes of the lesson, and the time was too short to complete the activities stated in the lesson plan. He also asked the group to choose another teacher to re-teach the revised lesson. The HOD reminded TA1 that lesson study requires the same teacher
to re-teach the revised lesson to a different class.

The observers raised five points during the discussion: writing the sub-heading of the topic on the chalkboard; use of the teaching aid; getting the views of students on what they understood about statistics before introducing the tasks; managing the time; and asking students to state the different ways of classifying data.

*Writing the sub-heading of the topic on the chalkboard.* One observer reminded TA1 that he should have written on the board the sub-heading on Statistics, “Collection and presentation of data” at the beginning of the lesson.

*Use of the teaching aid.* The HOD reminded TA1 that the *Under Five Card* should have been shown to the students so that they could understand the importance of statistics in the life situations
Figure 6.11. Transana Episodic Keyword Map Report for revising lesson 1 at School A
Getting the views of students on what they understood about statistics before introducing the tasks. The team agreed that TA1 should ask students to give their own views on what they thought statistics was and its importance. After that, TA1 could have introduced the teaching aid to students.

Managing the time. One observer raised the issue of managing the time during the lesson, stating that the students who volunteered to draw the pie charts on the board spent a lot of time. The team agreed that TA1 should stick to timelines set in the lesson plan. However, one teachers reminded the team that in order to stick to the timelines set in the lesson plan, they should not have implemented the 40-minute lesson in 24 minutes in the first place.

Asking students to state the different ways of classifying data. One observer raised proposed that students should be asked to state the different ways of classifying data (e.g. frequency tables), rather than jumping straight to pie charts. The team agreed that TA1 should do so in the next lesson.

The HOD asked TA1 to modify the lesson plan by including the points they had just discussed. TA1 confirmed that he had been modifying the lesson plan to include the issues raised during the discussion that just ended. TA1 asked the HOD if he was being asked to teach the revised lesson also. The HOD reminded TA1 that the same teacher would teach the revised lesson, but now to a different “morning stream” class, even though it would take place during the afternoon.

Re-teaching research lesson 1

On the same day, the same teacher re-taught the research lesson to a different Grade 12 class. It was a single period scheduled to last 40 minutes. As can be seen in Figure 6.12, the lesson lasted 31 minutes. The seven teachers who planned the research lesson attended the lesson.

As can be seen in Figure 6.12, the lesson introduction lasted about five minutes, the lesson development 16 minutes, the evaluation six minutes, and the conclusion three minutes.
Figure 6.12. Transana Episodic Keyword Map Report for re-taught lesson 1 at School A
Lesson introduction

The teacher asked students to give their views on what statistics were and where they are used. He further asked students to state various ways of presenting information. He then introduced the teaching aid (the Under Five Card from the School Health Centre) shown in Figure 6.13. He explained that the Under Five Card was used by nurses to plot the weight-against-age of the child from birth to five years. The Under Five Card and the chalkboard were the only resources used during the lesson.

![Figure 6.13. The teacher showing students an Under Five Card](image)

Lesson development

The teacher asked ten students to provide the marks they got on the end of Term 3, 2014 mathematics test and wrote the results on the board (43, 52, 54, 42, 45, 42, 43, 56, 42 and 60).

He firstly told the students that to draw a pie chart, they needed to represent each mark as a proportion of 360, because there are 360 degrees in a circle. He then introduced the concept “frequency” and explained how to use “frequency” to calculate the angles when drawing a pie chart. He gave the following formula to determine the angle of a sector in a pie graph:
The class activity was organised as individual work. Figure 6.14 shows students working individually on the task.

![Students working individually](image)

**Figure 6.14. Students working individually**

While students were working on the task, the teacher walked between the desks and encouraged students to complete the task. He used prompts in the form of questions. For example, he asked one student, “how do you calculate ratios?” After students had worked on the task individually, the teacher pointed to two students, shown in Figure 6.15 and asked them to draw their pie charts on the board. While the students were drawing the pie charts on the board, the teacher kept on reminding them to hurry up because there was no time.

After student A completed the pie chart, TA1 asked the class to comment on the chart. One student said that the pie chart was not correct because angles had not been calculated. Before commenting on pie chart A, TA1 asked student B why she had not completed her pie chart. She asked for a calculator and explained to the class that:

We need to find the total sum of marks. Thereafter, we need to calculate the angles of the marks using the formula, frequency of the mark divided by the total, times $360^\circ$. So we shall calculate the angles for all the marks.

(Student)
The teacher asked whether the explanation given by student B was correct. The class agreed that it was correct. TA1 then commented that pie chart A was not correct, but gave no reason or explanation of why it was incorrect. (In fact, other than omitting the mark of 45, student A’s pie chart was basically correct, showing the mark of 42 having the greatest frequency, and 43 having the next greatest frequency.)

Instead, TA1 commended the explanation given by student B, apparently
not noticing the fact that it is incorrect to “find the total sum of marks” and the fact that this was unlikely to just be an oversight by student B as she appeared to think that a calculator was required to find the correct angle sizes. After commending the explanation, TA1 recited the correct formula for calculating the angles, apparently not noticing the difference.

Lesson evaluation

The teacher asked six students to state their shoe sizes and wrote them on the board as 8, 7, 7, 9, 10 and 6. The teacher asked the students to present the shoe sizes on a pie chart, advising them to consider the angles on the pie chart.

Lesson conclusion

The teacher summarised the lesson, explaining how angles are calculated using frequency tables. Using the data on the shoe sizes, he said that the angle for size 6, whose frequency was 1, would be calculated as \( \frac{\text{Frequency}}{\text{Total}} \times 360^\circ \). The teacher complimented the students for being brilliant. He then invited questions from students. One student noted that the frequency of the mathematics best score 42 was not 2.

![Figure 6.17. Observers talking to the teacher during the lesson](image)

Finally, the HOD thanked students for their co-operation.

During the lesson, the observers sat at the back of the classroom. They did not have a checklist or a copy of the lesson plan. They did not take notes, video-recordings or photographs. However, observers talked to the teacher on three occasions as shown in Figure 6.17. However, the *Teaching Skills Book* discouraged teachers from sitting at the back of the class, stating, “The culture of sitting at the back by the observer is not allowed as one would not see the facial expressions on the face of the children. Walking around would help identify the actual skills
learners have or do not have” (MOE & JICA, 2009, p. 33).

Post-lesson discussion for lesson 1

The team held the post-lesson discussion immediately after the re-teaching of the revised lesson. As can be seen in Figure 6.17, the post-lesson discussion lasted 17 minutes. The seven teachers who planned the lesson attended the session.

The HOD chaired the discussion. He asked team members to comment on both the first and second lessons in terms of overall satisfaction, lesson presentation, learner participation, and adherence to the lesson plan.

TA1 was asked to speak first. In his analysis, he concluded that:

The revised lesson met the lesson objectives and the second class was more active and inquisitive than the first. The revised lesson enabled students to understand what statistics is and learn ways of collecting and presenting data. This was missing in the first lesson. (TA1)

One team member was worried that the solutions students presented before the class were not evaluated, asking TA1 to comment:

I need you to comment on this. I observed that there was a girl who was trying to calculate the angles by adding all the marks. This is another method of calculating angles using frequencies. So which method is which?

TA1 responded that he did not focus on methods for calculating the angles. All that mattered was that students should come up with correct angles:

Which method is which? Well, [I] was not looking at the two students’ methods. [I] did not compare work solutions they presented. The aim was to get the angles in conclusion. You must [use] the frequencies. Get marks, get shoe sizes and the frequencies, and get the totals of the frequencies, and look at individual size 5, 6 ... over the total frequency. (TA1)
Figure 6.18. Transana Episodic Keyword Map Report for post-lesson discussion of lesson 1 at School A
The Chairperson asked whether it would be wrong for students to add all the marks or shoe sizes. TA1 said that he was trying to think whether the two strategies – the one he introduced in class and the one the student used – came to the same thing. The HOD responded that the method of adding all the marks or shoes sizes was difficult, stating,

It was the reason we reduced the number of shoe sizes to 6, because it is easier to divide 360 by 6 and get a whole number. But if students had added all the numbers and get the total. For example, the mark 42 divided by the total number multiplied by 360 would give a result with decimal points. (HOD)

The planning team concluded that the two methods would yield the same results – which is incorrect. However, they did not perform any calculations to validate their conclusion. One observer also advised TA1 that he should refrain from providing answers to students:

I am reminded of an instance where the teacher asked students to state ways of presenting data, and one student answered "graph". The teacher quickly started talking about graphs. In my view, the teacher should have asked a follow-up question: “What do you mean by graph?” Or the teacher should have asked another student to elaborate on graphs. (TA1)

One teacher was against the idea of the teacher following the lesson plan word for word, stating that such strictness has negative effects on teaching:

The presenter wanted to follow what was written on the lesson plan word for word, a situation that had negative effects on the lesson. I think the teacher needs to exercise some flexibility.

The Chairperson stated that the teachers should take note of the deliberations and apply the findings to their own lessons. The Chairperson finally remarked that the lesson objective had been met; lesson study was not a mere CPD activity to fulfil the demands of the school; and that each teacher would receive a copy of the updated lesson plan.

6.2.2 Lesson study cycle 2

The research lesson for cycle 2 took place in Grade 11, on the topic of “Trigonometry”. This cycle was implemented five weeks after lesson study cycle 1 and, like lesson study cycle 1, it was completed in one day. There were two syllabi for mathematics at senior secondary
(Grade 10 – 12) in Zambia shown in Figure 6.19.

Figure 6.19. Senior secondary mathematics syllabi (MESTVEE, 2012).

The “O” Level Mathematics Syllabus was compulsory for all students, whereas the Additional Mathematics Syllabus was optional. Trigonometry in the “O” Level Mathematics Syllabus was a Grade 11 topic, comprising seven subtopics: there trigonometric ratios on a right-angled triangle; special angles (60°, 45° and 30°); three trigonometric ratios in quadrants; sine and cosine rules; area of a triangle; sine, cosine and tangent curves; and applications of
trigonometry. Further, the Syllabus specified the outcomes for each subtopic. For example, the outcomes for the subtopic three trigonometric ratios on a right-angled triangle were to define the three trigonometric ratios on a right-angled triangle, and to calculate sides of a right-angled triangle (MESTVEE, 2012). The definitions of sine, cosine and tangent first occurred under subtopic 1 (three trigonometric ratios on a right-angled triangle).

In the Additional Mathematics Syllabus, trigonometric functions were a Grade 10 topic with six sub-topics: six trigonometric functions; angles; graphs of sine, cosine and tangent functions; trigonometric equations; proofs for simple identities; and area of triangle.

**Planning research lesson 2**

The planning session was held in the Mathematics Department office. As shown in Figure 6.20, the planning team comprised the HOD of mathematics, and nine teachers of mathematics (TA1 – TA9). RS is the researcher and CM the professional cameraman.

![Planning team](image)

Figure 6.20. The planning team for research lesson 2

The HOD chaired the session. The teacher, who was to teach the research lesson, TA2, had already been chosen and was asked to complete the Lesson Plan Template during the eeting. The planning session lasted 50 minutes (see Figure 6.21).
Figure 6.21. Transana Episodic Keyword Map Report for planning research lesson 2 at School A
Lesson goals

The meeting started with TA2 proposing the following lesson objective: “At the end of the lesson, pupils will be able to use trigonometric functions to simplify trigonometric expressions”. The team members did not give their views on the lesson objective, but instead proceeded to discuss the activities for the lesson introduction, development, conclusion, and evaluation.

Lesson introduction

The discussion of the lesson introduction lasted 10 minutes, as shown in Figure 6.21. First, TA2 posed a question about the best way to introduce the lesson, bearing in mind that students should be able to simplify trigonometric ratios at the end of the lesson. The HOD asked whether students had some knowledge about trigonometry. The team had mixed views about students’ prior knowledge of trigonometry, but they could not substantiate their views as they did not have a copy of the mathematics syllabus. However, one teacher insisted that students had not studied trigonometry in previous years because the topic was covered in Grade 11.

In this lesson study cycle, the research lesson was to be taught to the Grade 11 class with all students taking only “O” Mathematics, and the lesson was to be re-taught to a Grade 11 class with some of the students also doing “Additional Mathematics”. Therefore, the second class would have students who had in knowledge about trigonometry, because, as stated earlier, in the Additional Mathematics Syllabus, trigonometric functions was a Grade 10 topic with six sub-topics.

The team debated whether pupils should answer the question: “What is Trigonometry?” TA2 did not deem it necessary to ask students to define trigonometry, stating:

We are only interested in the use of a right-angled triangle to derive ratios and use the derived ratios to simplify trig ratios. After all, I have never seen students asked to define trigonometry in the exams. (TA2)

TA1 stated that there should be an assumption that students knew the trigonometric ratios. The rest of the members did not agree, with TA2 replying that the team should not assume that students knew the trigonometric ratios without having any proof of this. Based on this discussion, the HOD asked the team to focus
on how TA2 should introduce the lesson to the students, stating, “What exactly should the teacher say to students?

   TA2 said that he would introduce the lesson using Pythagoras’ Theorem. He stated that he would draw the right-angled triangle and tell the students the names of its sides, to which one teacher objected, “Why tell them? Why not find out from them?” According to the Mathematics Syllabus, students learn Pythagoras’ Theorem in Grade 10 under the topic of Geometry. So, students should have had prior knowledge of properties of right angled triangles, Pythagoras’ theorem, and its applications.

   The team agreed that TA2 should introduce the lesson using a right-angled triangle, which he drew during the lesson as shown in Figure 6.22. The team cautioned TA2 not to tell students the names of the sides of a right-angled triangle, but instead ask students to name the sides. Students should also be asked to state Pythagoras’ theorem.

![Figure 6.22. The right-angled triangle for lesson 2](image)

Furthermore, the team agreed that TA2 should introduce angle $x$ at point B in Figure 6.22, and ask students to name the sides of the triangle with reference to angle $x$. At this point the HOD reminded the team that what followed after introducing angle $x$ in their right-angles triangle would be under lesson
Lesson development

As can be seen in Figure 6.21, the discussion of the lesson development lasted 10 minutes. The team agreed that students should be asked to name the three sides of the triangle. The team expected students to name AC as the Opposite side, AC as Adjacent and CB as the Hypotenuse.

The HOD suggested that the TA2 should ask students the following question: “What do we call angle AC/BC with reference to angle x?”

The team considered carefully how to frame the question for students, and agreed to pose the following question:

With reference to angle x, what do we call the trigonometric ratio

i. AC/BC,

ii. AB/BC

iii. AC/AB.

The team considered what they wanted students to say, with one teacher asking where student responses should be recorded on the lesson plan. TA2 showed her a column (Pupil Activity) on the lesson plan template for stating student activities. However, there was no column specifically for stating anticipated student responses as the column mentioned by TA2 was specifically for stating student activities.

The team stated student answers as (i) Sine x, (ii) Cosine x and (iii) Tangent x. They did not anticipate incorrect or partially correct answers. Since, the teachers had not agreed on whether students had prior knowledge of trigonometric functions, it was not clear whether or not students were meant to know the answers. The HOD urged TA2 to ask students to clarify their answers and to sum up the clarifications made by the students.

The HOD asked the team to consider how to use the three trigonometric ratios. One teacher stated that they should formulate a question that TA2 could use as an example. TA2 stated that he wanted to also introduce the inverses for the three trigonometric ratios before showing students an example of how to simplify trigonometric ratios.

At that point, the HOD reminded the team that, although the class for the
research lesson had two periods (80 minutes), today’s lesson would be taught in 40 minutes so that the remaining 40 minutes could be used for reflecting on the lesson. At this point the team had run out of the planning time, with the HOD stating:

So, let us be quick. Let me tell the class. The class was expecting us at 8.50 [am], and now it’s 9 [am]. Whatever time we finish, we’ll just teach it for 40 minutes. (HOD)

The team discussed how to introduce the inverse trigonometric ratios to students. They agreed that TA2 should write a short heading, “reciprocals”, and ask students to state the reciprocals of Sine $x$, Cosine $x$, and Tangent $x$. They anticipated that students would state the following:

i. Cotangent $x = \frac{AB}{AC} = \frac{1}{\text{Tangent } x}$

ii. Secant $x = \frac{BC}{AB} = \frac{1}{\text{Cosine } x}$

iii. Cosecant $x = \frac{BC}{AC} = \frac{1}{\text{Sine } x}$

The team considered the following two examples that TA2 could use to show students how to simplify trig functions.

Simplify the following:

i. $\sin x \cot x$

ii. $\sec x - \cot x$

The team simplified the two expressions. One teacher noted that students might face difficulties in understanding the how Cot $x$ was derived. The others, except for one other teacher, believed that Cot $x$ would not pose a big challenge.

i. $\sin x \cot x$

$$= \frac{AC}{BC} \times \frac{AB}{AC} = \frac{AB}{BC} = \cos x$$

ii. $\sec x - \cot x$

$$= \frac{BC}{AB} - \frac{AB}{BC} = \frac{1}{\cos x} - \frac{\cos x}{1}$$

The team was confident that after TA2 engaged the students by solving the
above two examples, students would be ready to attempt the evaluation exercise.

Lesson evaluation

TA2 proposed that students should be given one question for the evaluation exercise. The teachers agreed to give pupils an exercise to simplify $\frac{\sin x}{\csc x} + \frac{\cos x}{\sec x}$. The HOD stated that TA2 should mark students’ exercises in class to help evaluate the lesson objective. He reminded the team that the class for research lesson was still waiting, so they should hurry to the class.
Teaching research lesson 2

Lesson introduction

As can be seen from Figure 6.24, the lesson introduction lasted 4 minutes; the lesson development 18 minutes; the lesson evaluation 10 minutes; and the conclusion 46 seconds.

During the lesson introduction, the teacher wrote the title, “Trigonometry” on the chalkboard (see, Figure 6.25).

He further wrote, “Consider the right-angled triangle”, drew the triangle
ABC, and asked the students what they knew about the triangle. One student answered that it was a triangle with one $90^\circ$ angle. The teacher then asked students to name the sides of triangle ABC. Immediately, a student answered that the longest side of the triangle (BC) was the hypotenuse.
Figure 6.24. Transana Episodic Keyword Map Report for teaching research lesson 2 at School A
When TA2 asked the student what he knew about the hypotenuse, the student stated that the hypotenuse was equal to the square root of the sum of the other two sides squared. TA2 asked the class to consider the following:

\[(BC)^2 = (AB)^2 + (AC)^2\]

He asked the class to name this expression and some students answered, “Pythagoras’ Theorem”.

Figure 6.25. Introducing research lesson 2

Lesson development

The lesson development lasted 18 minutes. The teacher wrote the following expressions on the chalkboard (see, Figure 6.26) and showed students how to simplify the two expressions.

Simplify:

(a) \(\sin x + \cot x\)

(b) \(\sec x - \cos x\).
Figure 6.26. The teacher simplifying the expressions on the chalkboard

Lesson evaluation

The teacher gave students an exercise to simplify $\frac{\sin x}{\csc x} + \frac{\cos x}{\sec x}$. He asked students to complete the task in two minutes. However, the students worked on the question for about ten minutes. Most of the time the teacher stood at the front as shown in Figure 6.27.

Finally, the teacher invited the student shown in Figure 6.28 to simplify the expression on the chalkboard. In less than a minute, the student simplified it to $\sin^2 x + \cos^2 x = 1$. 

Figure 6.27. Teacher looking at students completing the exercise
The teacher marvelled at the student’s solution and asked the class to clap her. The class did not discuss the solution the student presented on the chalkboard as it was time to end the lesson.

Lesson conclusion

The lesson conclusion consisted of only one statement: “Thanks we end here”. The teacher did not summarise what the students might have learnt from the lesson. Time was up, and the HOD thanked the students for being attentive and well behaved.

Revising research lesson 2

During the lesson, three observers sat in the front row, focusing on the teacher; others sat in the middle, and the rest at the back. They did not have copies of the lesson plan. Only the HOD stood up to observe some students as they simplified the trigonometric expressions in their exercise books. The other observers did not take notes, photographs, or videos.

The lesson revision session lasted 3 minutes. This was because the period for re-teaching the lesson was starting within ten minutes. During lesson planning teachers had agreed that they would use the second half of the 80 minutes of class time to reflect on the research lesson. However, they used almost the first half of the 80 minutes planning the research lesson, so there was very little time left for revising the lesson.

Nine of the ten teachers who had planned the research lesson were present. The HOD chaired the session. TA2 was given a chance to speak first. Although he had been sceptical that
the lesson could be implemented successfully within 40 minutes, he stated that the lesson objectives had been met because many students used trigonometric ratios to simplify the trigonometric expressions.

The team agreed with TA2 that the lesson had been implemented successfully. However, the team noted that the teacher needed to face students when explaining and should be careful with the use of letters when simplifying expressions.

One observer advised TA2 to recognise students who raised their hands when they found the solution to the task. The HOD added that TA2 should do the marking at the time to motivate other students to work harder and finish the task. Another observer said that the words “we cancel” should be replaced with “we divide” when dealing with common parts in the expressions. The teamed concluded that they would go ahead and re-teach the lesson, and that these observations would be addressed.

**Re-Teaching research lesson 2**

As can be seen in Figure 6.29, the lesson lasted about 34 minutes. The teacher, who taught the research lesson, TA2, taught the revised lesson. All of the teachers from the planning team were present. The introduction took 6 minutes; the lesson development 20 minutes; and the lesson evaluation 6 minutes. There was no conclusion.
Figure 6.29. Transana Episodic Keyword Map Report for re-taught lesson 2 at School A
Lesson introduction

The teacher wrote the topic *Trigonometry* on the board and drew a right-angled triangle ABC as shown in Figure 6.30.

Figure 6.30. The teacher used the right-angled triangle to introduce the lesson

The teacher asked the students to state what they knew about the right-angled triangle. The students stated various properties of the triangle:

- One of the three angles $90^\circ$.
- The longest side is called hypotenuse.
- If you add the squares of the adjacent sides you get the square of the hypotenuse
- The area of the triangle equals half base times height.
- Angle ACB plus angle ABC is $90^\circ$.

The teacher later drew another right-angled triangle and asked one student to state what else could be inferred from the triangle. The student stated that its sides could be stated in terms of Sine, Cosine and Tangent. TA1 asked the student, “Where did you learn these concepts?” The student said that they learnt the concepts in Physics in Grade 10. The students stated Sin $x$, Cos $x$ and Tan $x$, and TA2 wrote them on the board as shown in Figure 6.31.
Lesson development

The teacher asked the students what would happen if the numerators and denominators were interchanged in the formulae. One student said, “We are going to have the inverse”. The teacher introduced and wrote on the board the inverse ratios as shown Figure 6.32.
Then TA2 illustrated how to simplify trigonometric functions using the two examples shown in Figure 6.33.

Figure 6.33. The two examples that the teacher simplified

TA2 simplified example (a) Sin x Cot x to Cos x. He also simplified (b) Sec x – Cot x to $\frac{1-\cos^2 x}{\cos x}$ as shown in Figure 6.34.

Figure 6.34. Simplifying example (b) Sec x – Cos x
While simplifying the two examples, TA2 asked students for their verbal input. For example, when simplifying example (b), he asked students to tell him Sec $x$. One student said that Sec $x$ was $\frac{BC}{AB}$, and another student said Sec $x$ was the inverse of Cos $x$, which was $\frac{1}{\cos x}$.

After TA2 wrote $\sec x - \cos x = \frac{1}{\cos x} - \frac{\cos x}{1}$, he asked what could be done next, and one student stated, “We can reduce the two ratios by using $\cos x$ as a common denominator”. Using this suggestion from the student, TA2 reduced the two ratios to $\frac{1 - \cos^2 x}{\cos x}$. Before arriving at this expression, there was a misunderstanding among some students about the product of $\cos x \cdot \cos x$. When TA2 asked for the product, some students shouted, $\cos x^2$, while other shouted $\cos^2 x$. TA2 then wrote $\cos^2 x$ and $\cos x^2$ on the board and stated that the correct expression was $\cos^2 x$.

Lesson evaluation

The teacher wrote the following exercise for students to complete.

Simplify $\frac{\sin x}{\csc x} + \frac{\cos x}{\sec x}$

As shown in Figure 6.35, TA2 walked between the desks checking students’ solutions and marking students’ books.
TA2 encouraged some students to try harder to simplify the expression. He did not invite students to present their solutions to the class as there was no time to do so because the class period was up.

Lesson conclusion

The teacher did not give any concluding remarks. It was time up for the lesson to end. TA2 stretched his hands towards the HOD as a signal that the lesson was over. The HOD stood up and thanked the students for their attention, saying “We enjoyed the lesson together”. The HOD then asked students to clap their hands for being attentive and active.

Observing the lesson

The observers remained in their seats during the lesson. They had no copies of the lesson plan. They did not take notes, photographs or video-recordings. They did not help students solve the exercise, or help the teacher present the lesson, or answer students’ questions.

Post-lesson discussion

About 10 minutes after the re-teaching of the research lesson, the team members met in the Mathematics Department Office to reflect on the re-taught lesson. The meeting lasted about three minutes.

The HOD thanked everyone for participating in the lesson study, despite their busy schedules. He stated that they were meeting to reflect on both the demo (research) lesson and the re-taught lesson, stating:

I know we have run out of time. We shall first get the views from the teacher who presented both lessons. In your view have we achieved the lesson objective? If yes, how and if no, why? (HOD)

TA2 stated that despite having no time to conclude the lesson, the lesson objectives had been achieved:

Our objective was for students to use trigonometric ratios to simplify the trig expressions. I believe the objective was achieved. (TA2)

The HOD asked the other teachers to comment on the two lessons. One teacher said that Lesson 2 was better than Lesson 1 because TA2 walked around
and marked students’ solutions, adding, “I think the changes we had made to the first lesson were all implemented in the last lesson”. Another teacher wanted to know from TA2 many students expressed the trigonometry correctly. TA2 stated that many students expressed the trigonometry correctly. As there were no other comments, the HOD concluded by stating, “From what we observed in the last lesson, we can say the lesson was successful. So, thanks for your time, and I will ensure that you get a copy of the final lesson plan”.

6.2.3 School A summary

This section summarises the implementation of lesson study as observed at School A.

School context

School A is a prestigious school, headed by a mathematics teacher who was trained in lesson study in Japan and who the Ministry has used to disseminate information about lesson study in the school district. During the interviews, the Head Teacher (HTA) stated, while in Japan, he had been impressed by the way that teachers engaged in lesson study, especially during the post-lesson discussions.

HTA stated that he joined the lesson study team regularly and that if he was out of the school, his deputy attended. However, contrary to this statement, neither he nor his deputy attended lesson study cycle 1 or 2. Moreover, during the interviews, the teacher of the second research lesson (TA2) commented that, contrary to the Implementation Guidelines, school administrators rarely participated in lesson study, which he regarded as a serious omission.

The mathematics department was relatively well-staffed with trained mathematics teachers and the student-teacher ratio for mathematics classes observed was 30:1.

The CPD co-ordinator (CA) believed that teachers who participated in lesson study learned a lot, resulting in more student-centred teaching and more uniformity among teachers’ lessons. However, CA was concerned that there was a low level of interest among teachers, especially those whose students already achieved good results in mathematics.

The Head of Department (HOD) appeared to have a good understanding
of the process of lesson study. He chaired the planning meetings and the post-lesson discussions; chose a topic for Research Lesson 1 that he believed to be challenging for teachers due to the varied background of students; suggested the use of the Under Five Card as a teaching aid to address the value objective of making mathematics meaningful for students; gave each member of the planning team a checklist for recording their observations; and reminded them that they should make a written record of their observations so that their notes could be used to evaluate and revise the lesson.

**Implementing the lesson study cycles**

Almost all members of the mathematics department took part in all phases of the two lesson study cycles, including two pre-service teachers during cycle 2.

Each lesson cycle had been planned to take place over two days, with the planning session originally scheduled for the day before the research lesson. However, on both occasions, the entire lesson study cycle was completed in just one day, using a fixed timetable, with the planning session taking place during the 40-minute period preceding the period for the research lesson. Teachers spent very little time in Planning Session 1 due to the late arrival of members of the planning team. Those who arrived late at the planning session said that they had been attending their classes to leave students with some work. As a result of the timetabling, both planning sessions overlapped with the lesson time, which then resulted in the lessons ending abruptly.

Although the HOD had reminded participants to record their observations of the research lessons, he was the only person to do so and was also the only observer to walk around and look at students as they were working on the tasks. Teachers spent limited time on post-lesson discussions, with a total of half an hour spent on discussing and revising research lesson 1 and discussing the revised version, and a total of just six minutes spent on the same discussions for research lesson 2.

**The mathematical focus of the planning team**

Teachers chose statistics because it was challenging topics to teach and for students, with the HOD stating that each year students struggled with statistics due to their varied backgrounds. However, the team did not identify and discuss what
students struggled with about statistics so that the mathematical focus could centre on identified issues. The team did not give reasons for choosing trigonometry topic.

The team planned to use the Under Five Card in research lesson 1 to address the value objective of making mathematics meaningful for students, with the HOD stating that its use would make students see and appreciate why they need to learn about statistics and where it is used in real life. However, while the use of the Under Five Card was agreed, this did not appear anywhere in the lesson plan and it was subsequently omitted from the research lesson, although it was used in the revised lesson.

In both research lessons, it was unclear what prior knowledge students were expected to have.

The planning team for research lesson 1 decided the lesson objective to be “At the end of the lesson, pupils should be able to collect and classify information correctly, with pupils getting at least five out of six questions correct.” However, the task for students focussed on correctly representing data collected by the teacher on a pie chart and there was no discussion of other possible representations of the data, nor was any classification of data involved. Moreover, it was not clear whether constructing pie charts was meant to be prior knowledge or whether this was meant to be learned through the lesson, and pie charts are not part of the Grade 12 syllabus.

In lesson 2, the stated objective was “At the end of the lesson, pupils will be able to use trigonometric functions to simplify trigonometric expressions”. However, the planning team were unable to agree on whether or not prior knowledge of trigonometric functions could be assumed and appeared unaware that the students in the Additiional mathematics class in the afternoon should have met these in Grade 10, while those in the morning class would, in all probability, nt have previously met these functions. (In fact, during the revised lesson, a student stated that they had learned about trigonometric functions in the previous year’s physics classes).

In both planning meetings the HOD told the teachers that they should discuss students’ solutions. However, in both meetings the planning team did not anticipate students’ solutions or plan any probing questions that they might use in such a discussion, with the focus being on students getting correct answers.
The mathematical focus of the teacher during the research lessons

In the first iteration of research lesson 1, the teacher gave no instruction on how to construct pie charts. So, it appeared as though students were meant to already know how to construct pie charts (a reasonable assumption since this does not appear in the Grade 12 curriculum). However, in the revised lesson the teacher introduced the concept “frequency” and explained how to use “frequency” to calculate the angles when drawing a pie chart, and summarised the lesson by explaining again how angles are calculated using frequency tables.

The teacher focussed mainly on the “correctness” of the numbers used in the three demonstrated solutions and did not ask the three students to explain, with reasons, the pie-charts they presented on the board. There was no comment on and no time for sufficient discussion of the fact that pie chart A included each data point as a separate segment of the pie chart (in fact there were 11 segments instead of 10, apparently due to the student misreading 46 in the data as 4 and 6), while pie chart B demonstrated that the student didn’t understand the concept of pie charts as the size of the segments appeared to correspond to the examination mark rather than the frequency of the examination mark. This point was raised in the post-lesson discussion after the revised lesson, but TA1 appeared unaware of the issue even then and said he only focussed on the students getting the “correct angles” rather than about how they obtained the angles. After students presented their solutions in research lesson 1, TA1 asked the rest of the class to comment on which pie chart was the best. However, he could not facilitate a detailed discussion because the planning team had not anticipated the possible responses and there was not enough time.

In research lesson 2, despite the fact that the planning team had been unable to agree on whether or not students had prior knowledge of trigonometric functions, the agreed lesson objective was stated as “At the end of the lesson, pupils will be able to use trigonometric functions to simplify trigonometric expressions”. Unsurprisingly, when the teacher asked students to simplify $\frac{\sin x}{\csc x} + \frac{\cos x}{\sec x}$ in two minutes, students worked on the question for about ten minutes. Nevertheless, the student selected to demonstrate her solution to the rest of the class completed the task in less than a minute. Students were not asked to comment on the solution their colleague had presented on the board, while in the re-taught lesson students were
not asked to present their solutions to the class.

**The mathematical focus for students during the research lessons**

It is difficult to find evidence about student thinking during the research lesson because some post-lesson discussions were very short, and post-lesson discussions rarely focussed on students' thinking (probably due to lack of evidence collected by the observers). However, one observer raised the point about a girl who was trying to calculate the angles by adding all the marks in the Revised Lesson 1 – something the teacher had not noticed. The discussion that followed showed that TA1 was unsure whether or not this would result in a correct pie chart – even after the HOD asked whether it would be wrong for students to add all the marks or shoe sizes. Surprisingly, the HOD commented that adding all the marks or shoes sizes was difficult because it would result in a decimal number, rather than commenting on the fact that such a method would result in an incorrect pie chart.

The fact that some students pointed out errors in the solutions shown and the fact that TA2 marvelled at the solution demonstrated by a student in Lesson 2, suggests that students were looking beyond just getting a correct answer. It also demonstrates the wide range of prior knowledge in the class and emphasises the need for the planning team to have anticipated student solutions when planning the lessons.

The post-lesson discussions allowed participants to consider ways that student thinking could have been probed during the lessons – for example, by getting the views of students on what they understood about statistics before introducing the tasks, as well as not just providing answers to students, but instead asking follow-up questions such as: “What do you mean by graph?” or asking other students to elaborate.

**Opportunities offered by the lesson studies observed**

The observed lesson studies at School A offered teachers a number of opportunities for professional growth. For example, through the question raised by one teacher during the post-lesson discussion about the (incorrect) method used by one student to construct pie charts, the opportunity existed for teachers to develop their skills and knowledge of the mathematics content of the curriculum. However, possibly due to the short time allocated to the post-lesson discussion, the issue of
whether or not the student’s method was correct was not resolved.

During planning for the second research lesson, it became obvious that teachers were uncertain about students’ prior knowledge of trigonometric functions and failed to take into account the fact that some students were studying the “O” level mathematics syllabus while others were doing Additional mathematics. Had there been more time available and had the Zambian syllabus been consulted, this would have also presented an opportunity for teachers to develop deeper knowledge of this area of the curriculum and the sequence of topics.

Teachers were also exposed to strategies for making their lessons more student centred through the discussions, for example when teachers suggested that the teacher of lesson 1 should ask students to give their own views on what they thought statistics was and its importance.

The products of the lesson studies also provided other opportunities for helping teachers improve their teaching. For example, the HOD stated that each teacher would receive a copy of the updated lesson plan and reminded them to apply the findings from lesson study to their own lessons.

6.3 School B: Lesson study cycles 1 and 2

School B, an urban day school, located in Central Province with enrolment capacity of 1000 on-campus students, was among the first schools in Zambia where lesson study in science was introduced in 2005. It was included in this study because the Ministry advised the researcher to use it as one of the case study sites, because of its long-standing history of lesson study.

At School B the student enrolment divides into two streams, the regular (the morning classes, also referred to as the core stream) and the APU stream (explained in 6.2 of this thesis). There were nine Grade 10 classes, eight Grade 11 classes and eight 12 classes, and nine APU classes. The Deputy Headteacher stated that the enrolment levels for the regular stream was 1100 and for APU 480 students, implying an average class sizes of 44 for regular stream and 53 for APU stream. The average student-teacher ratio for the regular stream mathematics classes that participated in the observed lesson studies was 50:1, a low ratio compared to some secondary schools in Zambia, where in 2013 the average student-teacher ratio was 56:1 (MOE, 2014, pp. 33-34), but higher than the ration of 30:1 observed at School
A.

The staffing level at School B was better than at many secondary schools in Zambia. To retain qualified teachers, especially holders of undergraduate degrees in mathematics and science education, the school administration had put in place a number of incentives. The incentives included allowing teachers to introduce and manage APU classes so that they could get extra income from APU student fees. The Deputy Headteacher stated, “The money mathematics teachers get from APU is a lot and it acts as an incentive to stay at this school because other schools don’t run APU classes”.

According to the Deputy Headteacher, teachers implemented lesson study in mathematics according to the recommendations in the policy documents. He further said the school administrators (himself and the CPD Co-ordinator) sometimes attended mathematics lesson study and gave guidance to the teachers. The Deputy Headteacher was standing in for the CPD Co-ordinator, who was on extended leave. He said that the mathematics department was supposed to conduct one lesson study cycle each month. He added that because of the overload from the syllabus and teachers’ involvement in invigilating national examinations, teachers were now only required to conduct one lesson study in term 3. The biggest challenge both administrators mentioned was that teachers did not have enough time to conduct lesson study.

6.3.1 Lesson study cycle 1

The research lesson for cycle 1 took place in Grade 10, on the topic of “Travel graphs”, with the subtopic “Distance-time graph”. Travel graphs was the second topic in the “O” Mathematics Syllabus for Grade 12. As shown in Figure 6.36, the topic comprised two subtopics: distance-time graphs and velocity-time graphs.
Under the first subtopic students were required to compute average speed and calculate total distance. The second subtopic required students to determine acceleration and retardation (deceleration), draw travel graphs, and calculate the distance in a velocity-time graph.

**Planning research lesson 1**

As shown in Figure 6.38, 8 of the 11 members the Mathematics Department planned research lesson 1. TB5 and TB7 were pre-service teachers on teaching practice. The HOD had delegated TB1 to chair the planning session and teach the research lesson.
Figure 6.37. Transana Episodic Keyword Map Report for planning research lesson 1 at School B
The planning session lasted 55 minutes. Figure 6.37 shows 12 minutes of the first part of the planning. The remaining 43 minutes were not recorded because the camera battery had not been charged the night before as there was no electricity supply.

The HOD introduced the topic for the research lesson as Travel graphs, stating that the lesson being planned was for Grade 10. A pre-service teacher (TB5) asked why they were using two sets of textbooks (Grade 9 and Grade 12 text book) to plan a Grade 10 lesson. TB1 checked the Syllabus, confirming, “You are right. Travel graphs are a Grade 12 topic. It is stated here on page 26 in our new Syllabus”. TB1 asked the HOD for direction. She advised the team to go ahead and plan the research lesson, stating:

I know the topic is for Grade 12 in our new syllabus. But if you remember, we used to teach time graphs in Grade 10 in the old syllabus. I don’t see any problem in using the topic for Grade 10s. We can go ahead with the planning unless anyone has a serious objection. (HOD)

The HOD did not make a comment on use of the Grade 9 textbook during the planning session. However, she commented to the researcher after the session that Travel graphs was a Grade 9 and Grade 10 topic in the old Syllabus, and that the content was similar. She clarified that the team used Grade 9 textbook because all the copies of Grade 10 text books from the Mathematics Department had been given out to students. The copy retained with the Department was with one teacher who did report for work on the day the research lesson was
planned. She added,

In fact, as a teacher of mathematics you can concur with that me that the Grade 9 textbook has very good exercises for students compared to Grade 10 textbook. So, there is no harm in using the textbook. However, we do not carry Grade 9 textbook in Grade 10 classes. (HOD)

The team wanted to implement the research lesson in the Grade 10A class. However, they agreed not to do so because the Grade 10A class was still doing Algebra. Instead, they agreed to implement the research lesson in Grade 10B during an 80-minute period.

Lesson goals

The planning team discussed and stated the lesson rationale as follows:

- **Content:** Compute average speed, distance and time.
- **Value:** Students would learn how to calculate speed when time and distance are given, in real life situations.
- **Method:** Discussion and demonstration

The team formulated the lesson objective as follows: “At the end of the lesson, students should be able to calculate average speed, time and distance”. Acceptable performance was regarded as getting three out of five questions correct. The team considered students’ pre-requisite knowledge and skills as being: operations on real numbers, units of measurements, changing the subject of formula, and substitution.

As shown in Figure 6.39 the team decided write Grade 12 textbook under the Teaching/learning material section of the lesson Plan template. They further decided that the questions for students’ exercise would be from Grade 9 textbook.

Thereafter, the team discussed the activities for the lesson introduction, development, conclusion, and evaluation.
LESSON PLAN (MATHEMATICS)

SUBJECT: MATHEMATICS  DATE: 17th June, 2015

NAME OF TEACHER:  TIME: 08:50

CLASS: I.O.B  DURATION: 80 Min

TOPIC: TRAVEL GRAPHS  NO. OF PUPILS:

SUB-TOPIC: Distance-Time Graphs  NO. OF BOYS:

NO. OF GIRLS:

RATIONALE

1. CONTENT: Compute average speed, distance and time

2. VALUE: Pupils will learn how to calculate speed given distance and time in real-life situations

3. METHOD/TECHNIQUE: Discussion, models and demonstration method

4. POSITION:

OBJECTIVES:

T.P.S & T: Calculate average speed, distance and time. Acceptable performance is getting 3 questions correct out of 5 questions of an exercise

PRE-REQUISITE KNOWLEDGE AND SKILLS:

-Knowledge and skills on the operation on real numbers, units of measurement, changing the subject of the formula and substitution

TEACHING/LEARNING MATERIALS:

-Grade 12 text book
-9th pupil text book page 125 to 126

RESOURCES:

TIME/PHASE | TEACHER ACTIVITIES | PUPIL ACTIVITIES
---|---|---
5 Min | The teacher will give a situation of trains, cars, bicycles or a journey between Lusaka and Kabwe covering a distance of 100 km in order to arrive at the concept of speed. | Pupils are expected to be attentive and participate accordingly. Some of the responses pupils should give may include: moving fast, high speed, slow etc.
<table>
<thead>
<tr>
<th>TIME/PHASE</th>
<th>TEACHER ACTIVITIES</th>
<th>PUPIL ACTIVITIES</th>
</tr>
</thead>
</table>
| Lesson Development 40 Min. | - Using the same relation of the journey, the teacher leads the pupils into the definition of speed/
velocity.
- The teacher will also lead the pupils into the formulation of the formula for speed: 
\[ \text{Speed} = \frac{\text{Distance Covered}}{\text{Time Taken}} \]
- The teacher will also give guidance on how the units for average speed is arrived at.
- A chart showing a summary formula is displayed.
- Next, the teacher will write the notes on the board followed by two examples for discussion.
| - Pupils will be expected to be attentive and respond to verbal question when asked.
- Pupils to give verbal examples on the units for speed given distance and time.
- Look at the chart for consolidation of the formula.
- Pupils will be expected to copy the notes into their note books.
- Pupils will be expected to participate in the discussion of the examples and have to copy the solutions.

| Lesson Evaluation 35 Min. | - The teacher will write question on the board for a class exercise.
| - The pupils will be expected to copy exercise question into their exercise books and attempt. |

SELF EVALUATION:

..........................................................................................................................................
..........................................................................................................................................
..........................................................................................................................................

*Figure 6.39. Lesson plan 1 for School B*
Lesson introduction

By way of introduction, the team agreed that TB1 would present a situation of two vehicles on a journey between, Lusaka and Kabwe, covering a distance of 100 km, to arrive at the concept of speed. One of the teachers, TB3, proposed that TB1 should state that a truck and a bus left Lusaka at 10:00 hrs in morning. The bus arrived in Kabwe at 12:00 hrs and the truck at 14:00 hrs. TB3 suggested that TB1 should ask students, “Why did the bus reach Kabwe earlier than truck?” The team agreed with TB3 and stated that students’ responses might include: moving fast, high speed, slow (see, Figure 6.39). The team stated that the students should be attentive and participate accordingly and that after students had given the answers to the question, TB1 should develop the lesson.

Lesson development

The team agreed that the teacher should use the same situation of the journey to lead students into defining speed and velocity, with TB2 stating, “You should lead the students into the formula for speed and allow them to respond to questions”. A pre-service teacher (TB5) was of the opinion that TB1 should not state the formula for speed but ask students to state it. The HOD agreed with the suggestion from TB5, stating, “After students have stated the formula, verbally or in writing, you should then display a chart showing a summary formula for students to consider”. They stated the formula as follows:

\[
\text{Speed} = \frac{\text{Distance covered}}{\text{Time taken}}
\]

The team stated that students should be asked to give examples of the units for speed when given the distance, with TB4 stating, “Give guidance on how the units for average speed were obtained and ask students to give examples of units for speed given distance and time”. The HOD added that TB1 should refrain from providing answers to students.

The team discussed whether TB1 should write the notes on the board for students to copy, with TB2 asking, “Do we have the notes ready?” TB1 showed the team members the notes he had drafted (See, Figure 6.40).
Average Speed and Velocity

Average Speed

Average Speed can be defined as the Distance Covered per unit Time.

Velocity

Velocity can be defined as the Distance Covered per unit Time in a specified direction.

Formula

Speed can be found by:

\[ \text{Average Speed} = \frac{\text{Total Distance Covered}}{\text{Total Time Taken}} \]

- \( S = \frac{D}{T} \)

Units:

The units for speed can be derived from the units of distance and time in a given question.

For example, if the distance is in meters and time in seconds then the unit will be \( \text{m/s} \).

Examples

1. A bus travelled 276 km between Karura and Malinga. If the bus started off from Karura at 8:00 am and arrived in Malinga at 12:00 pm, what was its average speed?

Solution

\[ \text{Average Speed} = \frac{\text{Distance}}{\text{Time}} \]

Distance = 276 km

Time = 12:00 - 08:00

= 4 hours

\[ \text{Average Speed} = \frac{276}{4} \]

= 69 km/h

2. The average speed of a horse is 22 km/h. How long does it take to run a distance of 900 m?

Solution

\[ \text{Speed} = \frac{\text{Distance}}{\text{Time}} \]

Distance = 900 m

Convert 900 m to Kilometres, because

1 km = 1000 m

\[ y = 0.9 \]

\[ \frac{1}{2} y = \frac{0.9}{100} \]

1000 m = 1 km

1000 m = 900

\[ y = 0.9 \text{ km} \]
Figure 6.40. The notes for Lesson 1
The team agreed that TB1 should write the notes on the chalkboard followed by the following two examples for students to copy solve and discuss:

(i) Bwalya cycles a distance of 20 km in 80 minutes. What was his average speed in km/hour?

(ii) The average speed of a horse is 27 km/h. How long does it take to run a distance of 900 m?

The students were expected to participate in the discussion of the examples. TB1 stated that he had already stated the answers in the notes he had prepared.

Lesson evaluation

To assess whether the lesson objective was met, the team agreed that TB1 should write the following three questions on the chalkboard as a class exercise and ask students to copy and attempt them.

1. How long does it take a boy to run 300 m if his average speed is 5 m/s?
2. The average speed of a tram is 50 km/h. How far does it travel in 6 hours?
3. A car travels for 2 hrs at a speed of 55 km/h and 3 hours at a speed 60 km/h. Calculate:
   a. The total distance it has covered.
   b. The average speed for the whole journey.

TB1 assured the team that he had already solved the above questions and stated the answers in his notes.

Lesson conclusion

The team did not discuss how TB1 should conclude the lesson. On the lesson plan template there was no section for stating activities for the lesson conclusion (see, Figure 6.39).

The team discussed when the research lesson should be taught, and the HOD directed that it should be taught on the following day, stating:

I know some of us are not happy about the period for teaching this demo lesson. I want all of us to observe the lesson tomorrow. I know we have busy schedules, but all are required to participate in lesson study. (HOD)

She thanked everyone and reminded the team that they would meet immediately after the lesson to revise the lesson based on classroom observations and prepare for the next class.
Teaching research lesson 1

The lesson was taught on the following day and was attended by five people – TB1, the HOD, a teacher and the two pre-service teachers on teaching practice. As can be seen in Figure 6.41, the lesson lasted about 1 hour and 12 minutes. The introduction took 14 minutes; the lesson development 41 minutes; and the lesson evaluation, 17 minutes. There was no conclusion to the lesson.

Lesson introduction

The teacher, TB1, introduced the lesson by stating that people travelled daily from Lusaka to Kabwe or from Kitwe to Kabwe. He then asked students to state what was involved in such journeys. One student said, “time”, another said “distance”, and another said “speed”. The teacher commented that one could not travel without covering distance, and that one could not move some distance without speed and time.

TB1 told students to consider a journey of 100 km from Lusaka to Kabwe involving a Euro-bus and a truck. Both vehicles started from Lusaka at 10:00 hrs. However, the Euro-bus arrived in Kabwe at 12:00 hrs while the truck arrived in Kabwe at 14:00 hrs. The teacher asked students to state which of the two vehicles arrived earlier in Kabwe and why. The students answered that the Euro-bus arrived earlier than the truck. The reasons put forward were: “speed”, “the Euro-bus follows the time schedule”, and “the Euro-bus was faster than the truck”.

Lesson development

The teacher showed the students how to find the number of kilometres the Euro-bus covered per hour, which was 50 km per hour. Figure 6.42 shows TB1 calculating the speed of the Euro-bus. He wrote 2hr, drew a long dash and wrote 100 km, while stating, “It took the bus 2 hours to cover 100km”. He then wrote 1hr followed by a dash and the variable “y”. He said that the journey took 2 hrs with the total distance of 100 km. He stated that he wanted to find out the number of kilometres (y) the bus covered in one hour. He cross-multiplied “y” with 2 hrs and 1 hr with 100km. He then made “y” the subject of the formula.

Later TB1 calculated the number of kilometres covered per hour by the truck – 25 km per hour.
Figure 6.41. Transana Episodic Keyword Map Report for teaching research lesson 1 at School B
The teacher stated that the Euro-bus covered a greater distance per hour than the truck. The teacher defined speed as the distance covered per unit time, which in this case is the distance covered per hour.

The teacher said that time may also be in minutes. He wrote the definition of average speed on the chalkboard and later wrote the formula as

\[
\text{Average speed} = \frac{\text{Total distance}}{\text{total time}}
\]

The teacher introduced the Euro-bus data into the formula and wrote: \( X = \frac{100 \text{ km}}{2 \text{ hrs}} \), where \( X \) is the speed, saying, “We divide 100 by 2, and get 50. And remember that we have km per. So, we have 50 km per hour”

TA2 then wrote the following example on the chalkboard: Bwalya cycles a distance of 20 km in 80 minutes. What was his average speed in km/hour?

The teacher asked the students what should be done since the time is given in minutes and not hours. A student answered that the 80 minutes should be converted to hours, which is \( \frac{4}{3} \) hours. The teacher found the solution as 15 km/h.

The teacher wrote another example on the board as follows: *The average speed of a horse is 27 km/h. How long does it take to run a distance of 900 m?*

It is worth noting that so far all of the problems had been solved by the teacher, but now the students were being asked to solve this problem, for which they did not have a formula, and which would require the transposition of the formula for average speed.

The teacher stood in front of the class while students attempted the
problem. Many students converted 900m to kilometres to 9/10km. After a few minutes, TB1 asked students to state the answer to the problem.

One student said 2 minutes and some students in the class agreed with her. When TB1 asked the student how she had arrived at the answer, she stated that she had arrived at the answer of 1/30 hrs, which she converted to 2 minutes. The teacher told the class to clap the student and there was no further discussion.

Lesson evaluation

The teacher then wrote the following three questions on the chalkboard and asked the students to attempt them all:

1. How long does it take a boy to run 300 m if his average speed is 5 m/s?
2. The average speed of a tram is 50 km/h. How far does it travel in 6 hours?
3. A car travels for 2 hrs at a speed of 55 km/h and 3 hours at a speed of 60 km/h. Calculate:
   a. The total distance it has covered.
   b. The average speed for the whole journey.

The students solved the problems individually while TB1 and the four observers shown in Figure 6.43 walked between the desks, marking the work of students who raised their hands.

![Figure 6.43. Observers marking students’ books during the lesson](image)

The students were not invited to present their solutions before the class. About thirty seconds before the end of the lesson, TB1 asked the students to
complete questions 2 and 3 during prep and takes their books to the teacher for marking in the afternoon.

Lesson conclusion

There was no plenary session for concluding the lesson as time was up. TB1 concluded the lesson in one sentences: “Since time is up, the remaining questions should be answered later”.

Revising lesson 1

Four members of the Mathematics Department shown in Figure 6.44 revised the research lesson. However, TB7 did not attend the whole session because he was later excused by the HOD to leave the meeting. As can be seen in Figure 6.45, the lesson revision session lasted about 15 minutes. TB1 — the teacher who taught the research lesson – chaired the session. TB1 wanted to find out if the lesson objectives were met, and whether the use of the chart shown in Figure 6.44 and other examples had been effective in helping students learn.

Figure 6.44. Teachers discussing the chart used in the lesson
Figure 6.45. Transana Episodic Keyword Map Report for revising the lesson 1 at School B
A pre-service teacher (TB5) commented that the chart that TB1 had presented before the class showed the formula for speed only. He proposed that the chart should be revised to show the formula for distance and time. He added,

I know that pupils are supposed to use the pre-requisite knowledge on the changing the subject of the formula. However, in our case I feel they should be shown the formula for distance and time so that they concentrate on addressing other challenges posed by the questions, such as changing minutes into hours.

The team members did not object the inclusions suggested by TB5, with the HOD stating that TB1 should re-draw the chart to include the formula for distance and that for time.

Another point of discussion was about the duration of the lesson. TB7 noted that the content of the lesson was too little to be taught in 80 minutes. The HOD asked TB1 to comment on the suggestion given by TB7. He replied that 80 minutes was too much time and proposed that the lesson should be retaught in 40 minutes.

TB5 observed that that it would benefit the students more if they came up with a formula from the situation the teacher had presented in class. TB1 further asked the observers if the units for speed came out from the example of the Euro-bus and the truck travelling from Lusaka to Kabwe. A pre-service teacher commented that the units written on the chalkboard were able to be clearly seen and TB1 advised the pre-service teachers that whenever language or terms, such as how long, how far, are used they should be explained to the students.

Before ending the session, the HOD reminded TB1 that he should include the points raised during the session in the revised plan.

Re-Teaching research lesson 1

A different teacher, TB2, re-taught the revised lesson on the following day. TB2 had participated in the planning session but had not observed the lesson. The HOD said that TB1 could not teach the revised lesson because he was on sick leave.

The lesson was observed by the HOD and the two pre-service teachers, who, together with TB2, were the only members of the original planning team of eight to attend.
As can be seen in Figure 6.46, the revised lesson lasted about 35 minutes, instead of 40 minutes because the lesson started late. The introduction took 9 minutes; the lesson development 7 minutes; and the lesson evaluation, 19 minutes. There was no conclusion.

Lesson introduction

TB2 introduced the lesson by asking students who had travelled to Lusaka to state the mode of transport they used. One student said bus, another train. The teacher said that he had used a friend’s vehicle, a private car.

He then told students to consider a journey of 100 km from Kabwe to Lusaka for the teacher in a private car and the student on a bus. Both vehicles started from Kabwe at 07:00 hrs. However, the private car arrived in Lusaka at 08:00 hrs while the bus arrived in Lusaka at 12:00 hrs. The teacher asked students to state differences in the two journeys regarding the time. Students answered the private car took one hour whereas the bus took four hours. The teacher asked students what they thought was the reason for this difference in the times.
Figure 6.46. Transana Episodic Keyword Map Report for re-teaching the revised lesson 1 at School B
The students answered that the car was moving faster than the bus. Other said the bus kept stopping on the way dropping off passengers. Later, TB2 defined average speed as being equal to total distance travelled divided by the total time taken. He asked students to copy the definition.

Lesson development

The teacher wrote an example for pupils to copy: *The distance from Lusaka to Solwezi is 396 km. A bus travelled from Lusaka at 06:00 hrs and arrived in to Solwezi at 12:00 hrs. What was its average speed?*

TB2 divided the class into four groups and asked each group to solve the problem and choose a group representative for presenting the solution. The students solved the problem in groups, as shown in Figure 6.47.

Figure 6.47. Students solving the problem in groups

After about 5 minutes, TB2 asked each group representative to present the solution verbally, or in writing. All the four groups presented their answers verbally. Three groups got the correct answers. The answers were not discussed.

Lesson evaluation

TB2 wrote the following questions on the board for students to solve individually.

1) Bwalya cycles a distance of 20 km in 80 minutes. What was his average speed in km/hour?
2) How long does it take a boy to run 300 m if his average speed is 5 m/s?

TB2 did not walk between the desks to check students’ solutions. Instead, the observers checked the solutions each group had derived. They also answered students’ questions. Figure 6.48 shows an observer talking to one of the six groups.
Lesson conclusion

There was no plenary conclusion to the lesson. Instead, TB2 thanked students for having participated in the lesson.

Post-lesson discussion of lesson 1

The post-lesson discussion was held immediately after the lesson in the home craft classroom. The room was noisy as students were shouting outside. The HOD, TB2 and the two pre-service teachers attended the post-lesson discussion, which was chaired by the HOD. Figure 6.50 shows that the discussion lasted about 13 minutes. The points of discussion were the challenges faced by TB1 and students, and the lesson objectives.

The HOD opened the meeting by emphasising that she was impressed with the lesson. She asked TB2 to comment on the lesson starting with the lesson introduction. TB2 declined to comment on the lesson, stating, “I cannot evaluate myself. I want you to comment on the lesson”. The HOD asked TB2, “Did you face any challenges or did the students face any challenges?” TB2 said that the
chalkboard was in a deplorable state, empathising, “It was hard for me to write on the chalkboard. It was very slippery”.

The pre-service teacher in Figure 6.49 stated that the majority of students whose books he had marked faced difficulties in changing the subject of the formula for speed.

Figure 6.49. The pre-service teacher stating the challenges students faced

The HOD agreed that many students failed to change the subject of the formula, stating, “It’s very good that you emphasised the formula for speed just before the lesson ended. It would have been more beneficial to students if you gave them the formula for time and distance”.
Figure 6.50. Transana Episodic Keyword Map Report for post-lesson discussion for lesson 1 at School B
The HOD asked TB2 to state if the lesson objectives had been achieved. TB2 read the lesson objective, “At the end of the lesson, students should be able to calculate average speed, time and distance”. He commented many students were able to achieve this objective. The HOD said that lesson objective was too general, adding,

If the objective had specified the percentage of students who were able to calculate the average speed, time and distance without difficulty, that could be better. But as it is, we can say the objective was achieved.

(HOD)

The HOD thanked everyone and reminded the researcher about the dates for the next lesson study cycle.

6.3.2 Lesson study cycle 2

This lesson study was conducted for Grade 12 on linear programming, the third topic for Grade 12 in the “O” Level Mathematics Syllabus. The topic had three subtopics, namely, linear inequalities in one variable, linear inequalities in two variables, and linear programming as shown in Figure 6.51.

Figure 6.51. The subtopics on linear programming in the New Syllabus

According to the syllabus, the outcomes for the topic were that students should: find solution sets of linear inequalities; plot graphs of inequalities in two valuables; shade wanted or unwanted regions; describe the wanted or unwanted regions; determine maximum and minimum values; and use the search line to determine the maximum and minimum values.
Planning research lesson 2

Four members of the Mathematics Department (including the HOD) attended the planning session. Pre-service teachers did not attend the planning meeting, as they were attending to the lecturer who had come to monitor their teaching practice. As can be seen in Figure 6.52, the planning session lasted 56 minutes. The HOD had appointed a teacher, TB3, to chair the planning session and teach the research lesson.

Lesson goals

After TB3 introduced the topic, the team stated the Lesson rationale as follows:

- **Content:** Teaching linear programming.
- **Value:** (They did not state the value of the lesson – see Figure 6.54)
- **Method:** Demonstration, question and answer, and teacher exposition.
- **Position:** Lesson 1 in a series of 8 lessons.

After deciding on the rationale, the team agreed on two lesson objectives, namely that students should be able to solve linear inequations and draw graphs of linear inequations.

The team decided that knowledge of linear equations and plotting coordinates was required for the lesson. The team stated that the teaching/learning aids that would be used were a chart and the students’ mathematics textbook.
Figure 6.52. Transana Episodic Keyword Map Report for planning research lesson 2 at School B
Lesson introduction

The team decided that the teacher should introduce the lesson by asking the students to solve the equation $3x - 1 = 2x + 5$ and to draw its graph. The team allocated 10 minutes for the lesson introduction.

Lesson development

The team decided that in lesson development TB3 should explain how to find the solution to the equation used in the introduction and allow students to ask questions. Thereafter, he should introduce and demonstrate how to solve three inequations:

(i) $x + 3 < 8,$
(ii) $4x - 3y \geq 18,$ and
(iii) $3x + 2y \leq 6$.

The team decided that students should copy the three inequations in their notebooks, listen as the teacher demonstrates on the chalkboard, and attempt to answer questions.

Lesson evaluation

The team decided that the teacher should give students 35 minutes to work on an exercise while walking around the class, marking student’s work.

Figure 6.53 shows teachers searching for suitable tasks in the text book. Although they chose some questions from the text book, they did not state them in the lesson plan (see Figure 6.54).
Lesson conclusion

The team agreed that the teacher should conclude the lesson by emphasising the main points on a chart, especially the use of the signs $<, \leq, >, \geq$. The chart was going to be constructed by the teacher who was going to teach the lesson. During the conclusion, students should listen and ask questions when they did not understand. The team apportioned 5 minutes for lesson conclusion.
### Teaching research lesson 2

The lesson was taught the day following the planning session. The only member of the planning team to attend the lesson was the HOD. TB1, who was not part of the planning meeting, taught the lesson because TB3 was absent.
As can be seen in Figure 6.55 the lesson lasted about 1 hour and 20 minutes, with the time spent on the introduction being 4 minutes, and the lesson development, 1 hour and 16 minutes. There was no lesson evaluation and no conclusion.

Lesson introduction

The teacher introduced the lesson by asking the students what they knew about linear programming. He later used the equation \( x + 2 = 1 \) to introduce the inequality \( x + 2 < 1 \). He plotted the solution for \( x + 2 < 1 \) on the number line. He went on to explain the difference between solutions for \( x < -1 \) and \( x \leq -1 \).

Lesson development

TB1 wrote \( x + y < 3 \) and asked students how such inequalities could be solved. A student wanted to go to the front and explain how to solve the inequality; but the teacher asked him to explain from his desk instead. The student said:

Solving the given inequality is very like solving an equation. But, sir, ... we do most of the same things ... but we must also pay attention to the direction of the inequality.
Figure 6.55. Transana Episodic Keyword Map Report for teaching research lesson 2 at School B
The teacher explained that the solution to an inequality with two variables required graphs.

To draw a graph for a linear inequality in two variables (for example, \( x \) and \( y \)), we first get \( y \) alone on one side. After this we study the related equation we get by changing the inequality sign to an equals sign. We know that the graph will be a line. (TB1)

TB1 asked the students what was meant by a “strict inequality” and what type of the line its graph was. Four students raised their hands, and the one the teacher pointed at said that a strict inequality had a “greater than” or “lesser than” sign and that its graph was a solid line.

TB1 asked the class to respond to the answer given by their colleague and pointed at one of the seven students who raised their hands. The student said that he had no objection with the definition of the strict inequality that his colleague had put forward. But he said that the graph of a strict inequality was a dashed line, and that if the inequality was not strict its graph was a solid line.

TB1 followed up with the question, “What do you mean by saying the inequality is not strict?” Another student responded, “Sir, it’s an inequality with a sign greater or equal to or less than equal to”. The teacher asked the class to comment on the answer given by their colleague, and many students shouted, “correct”.

TB1 explained further that when drawing the graph, one should first pick one point not on the line and decide whether its co-ordinates satisfied the inequality or not. He said, “If they do, shade the half-plane containing that point, and if they don’t, shade the other half-plane”. TB1 asked for any questions from the class. No student asked him a question. He then told the students to take their books and copy the notes he was about to write on the chalkboard. Writing the notes consumed a lot of time.

Later TB1 wrote the following inequalities on the chalkboard and told students he was going to solve (i) and students would solve (ii) and (iii) individually.

\[
\begin{align*}
(i) & \quad x + 3 < 8 \\
(ii) & \quad 4x - 3y \geq 18 \\
(iii) & \quad 3x + 2y \leq 6
\end{align*}
\]

TB1 solved (i) asking students to pay attention. He said that the first step
was to subtract 3 from both sides of the inequality: \( x + 3 - 3 < 8 - 3. \)

The second step was to simplify this to \( x < 5. \)

The teacher went on to draw the graph, which looked like Figure 6.56, explaining that the line \( x = 5 \) should be dashed.

![Graph](image)

Figure 6.56. The graph for \( x < 5 \)

The students did not have any questions after the teacher had completed solving (i).

**Lesson evaluation**

After the teacher asked the class to solve (i) and (ii), the 80 minutes allotted for the lesson was over. TB1 spent a lot of time on the lesson development resulting in students not being given the exercise.

**Lesson conclusion**

There was no lesson conclusion because TB1 said there was no time left.

**Revising lesson 2**

As can be seen in Figure 6.57, the lesson revision lasted 1 hour and four minutes. Only TB1 and the HOD met to revise the lesson. The HOD gave TB1 the chance to speak about the lesson he had taught.
Figure 6.57. *Transana* Episodic Keyword Map Report for revising the lesson 2 at School B
TB1 asked the HOD to consider that he did not participate in research lesson planning and therefore, he might not have delivered the lesson according to the way the planning team had conceptualised it. He asked the HOD for her feedback on the lesson. The HOD indicated that the lesson study requirements had not been met. First, the teachers who had planned the lesson did not attend its implementation. She said that teachers made excuses, saying that they were busy teaching their classes.

She said that TB1 was supposed to use a chart about graphs and not about inequality symbols. The chart meant to communicate the symbols used in solving inequalities. Nevertheless, students had learnt something and had participated actively in the lesson.

TB1 and the HOD agreed that the lesson should be introduced from the main heading of the topic through questioning the students. The students should pay attention and contribute. The lesson introduction should take five minutes and not 10 minutes. The teacher should engage students in discussing equations and inequalities. After that, the teacher should disclose that the solutions of inequalities could be shown on the graph. The teacher should display a chart and give examples for discussion. The HOD and TB1 decided that the teacher should write the following on the board:

Illustrate the solution of the following inequalities by shading the region that satisfies the given inequality

(a) $2y + 1 > y + 4$,  (b) $5x - 3 \leq 7x + 7$.

At this point, students should observe the chart, write notes and discuss. The HOD and TB1 allotted 40 minutes for these activities.

TB1 and the HOD agreed that the teacher should write five questions on the chalkboard as an exercise. Students should copy and attempt the questions. The teacher should walk around the room marking students’ work. The exercises were intended to be completed in 35 minutes.

**Re-teaching research lesson 2**

TB1, the HOD and two pre-service teachers attended the re-teaching session. As can be seen in Figure 6.58 the re-taught lesson lasted 52 minutes.
Figure 6.58. Transana Episodic Keyword Map Report for re-teaching the revised lesson 2 at School B
Lesson introduction

TB1 introduced the lesson by asking students what linear programming dealt with. One student answered that it dealt with inequations. Another student answered that it dealt with maximisation and minimisation of linear equations.

(a) $2y + 1 > y + 4$,  (b) $5x - 3 \leq 7x + 7$.

Lesson development

TB1 wrote the following task on the chalkboard as an example:

Illustrate the solution of the following inequalities by shading the region that satisfies the given inequality

In answering question (a), the students stated that the inequality should be simplified before drawing the graph. The teacher explained to the students as he simplified the inequality to $y > 3$. When asked by the teacher what should happen next, one student answered that the inequality $y > 3$ should be changed to an equation, $y = 3$. The teacher told the class that it was much easier to draw a graph using an equation.

The teacher explained that the line $y = 3$ will be horizontal or parallel to the x-axis; the solution line would be broken; the solution line is named $y = 3$; and the area above the line $y = 3$ should be shaded as the solution.

TB1 proceeded to simplify (b) while talking to students and got $-2x \leq 10$. He further reduced this to $x \geq -5$ and explained why the sign $\leq$ changed to $\geq$. The teacher drew a solid line $x = -5$ and asked the students to state the region whose values were greater than or equal to $-5$. A student answered, “the left side of the graph”. The teacher then asked whether $-6$ was greater than $-5$. The students said that it was less than $-5$. So, the teacher shaded the right-hand side of line $x = -5$ as the solution.

A student asked the teacher which region should be shaded – the wanted or the unwanted region. The teacher answered that a given question would dictate the region to shade.

Lesson evaluation

Later, TB1 wrote the following exercise for students:

(a) $3x + 6 > 2x + 3$,  (b) $8y + 3 \geq 12y - 5$ and (c) $y + 6 > -4$.

TB1 walked between the desks, marking students’ books. The three
observers (the HOD and two pre-service teachers on teaching practice) sat at the back of the classroom during the lesson introduction and development. However, as can be seen in Figure 6.59, during the lesson evaluation the observers walked between the desks, marking students’ books.

Figure 6.59. The teacher and observers marking students’ books

Lesson conclusion

There was no conclusion to the lesson. The lesson ended after TB1 asked students to solve the remaining two questions,

(b) $8y + 3 \geq 12y - 5$ and (c) $y + 6 > -4$,

and take their books for marking before “prep” ended. He also told students not to forget which region to shade.

Post-lesson discussion of Lesson 2

As can be seen in Figure 6.60, post-lesson discussion lasted 11 minutes. The HOD and TB1 met for a post-lesson discussion in the HOD’s office. Five minutes after the session has started, the two pre-service teachers joined the discussion.

TB1 chaired the post-lesson discussion and noted that he should have introduced the lesson using only one variable, either $x$ or $y$ but not both, and should have paid attention to graphing the solutions. He then asked the pre-service teachers to state what they learned from the lesson. One pre-service teacher stated that when solving the inequations, students should be shown that whatever you do one side of the equation should also be done to the other side. The pre-service teacher stated further that the teacher should emphasise the difference between graphs for $x = 2$ and $y = 2$ so that students understand well.
Figure 6.60. Transana Episodic Keyword Map Report for post-lesson discussion for lesson 2 at School B
The other pre-service teacher said that although the lesson was okay, the teacher should have allowed students to participate more in the lesson. TB1 stated that time constraint was a factor in not allowing students to come to the front and solve problems.

TB1 asked whether the notes he wrote on the chalkboard consumed a lot of time. The observers stated that the notes did not consume much time. TB1 advised that in teaching the lesson they should avoid introducing both inequations in one and two variables at the same time so that students are given time to understand well the nature of graphs and the areas to shade.

The discussion ended after the HOD thanked everyone and stated that the lesson study cycle had been completed.

6.3.3 School B Summary

This section summarises the implementation of lesson study as observed at School B.

School context

School B was among the first schools in Zambia where lesson study was introduced in 2005. While the school was relatively well staffed and had a relatively low student-staff ration, it had dilapidated infrastructure, with chalkboards in some classrooms almost impossible to write on.

During the interviews, the Head Teacher (HTB) stated that he had learned about lesson study from a group of teachers who had been sent to Kenya where a lesson study program had been implemented, while TB1 reported having sourced lesson study information from teachers within the school who had attended lesson study workshops.

HTB believed that teachers participating in lesson study learnt how to deliver lessons and expanded their knowledge in mathematics, while TB2 believed that lesson study helped both the teachers and students better understand concepts. HTB believed that lesson study needed to be prioritised and more funds allocated to it so that teachers could conduct lesson study more than three times in a term. The School Inset Co-ordinator was supposed to attended lesson study for every department and prepare a report, while HTB said he also attended lesson study sessions when he was not busy. As a school with a long history of involvement in
lesson study, its teachers were sometimes invited to facilitate lesson study at other schools. However, HTB was concerned that some teachers thought lesson study was a waste of time.

**Implementing the lesson study cycles**

In both observed lesson study cycles, almost an hour was devoted to the planning session for the research lesson, with the planning taking place on the day before the lesson was taught. However, while a total of eight people, including two pre-service teachers, took part in the planning session for lesson 1, only the HOD, TB1 (the teacher who taught the lesson), the two pre-service teachers, and one other teacher (who was later “excused” from attending the session revising the lesson) attended the actual lesson. This was even though the HOD had reminded everyone to come to the lesson no matter how busy they were. The lesson was re-taught by a different teacher, TB2, who had taken part in the planning but had not attended the actual lesson, with only the HOD and the two pre-service teachers attending the revised lesson and taking part in the 13-minute post-lesson discussion. Notably, the original lesson 1 was planned for (and took almost) 80 minutes while the revised lesson took just 35 mins (instead of the planned 40 mins). The revised lesson was planned for 40 minutes instead of 80 minutes, after the planning team reached a consensus that the content of the lesson was too little to be taught in 80 minutes.

The planning team for lesson 2 comprised just four people – the HOD, TB3 who was going to teach the lesson, and the two pre-service teachers. The actual lesson was taught by TB1 as TB3 was absent. TB1 had taught the first iteration of research lesson 1 but had not attended the planning session for this lesson. Only the HOD attended. However, the HOD and TB1 spent over an hour revising the lesson, which was then re-taught by TB1 and observed by the HOD and two pre-service teachers, all of whom participated in a short post-lesson discussion.

During the revision session for lesson 1, the HOD indicated that the lesson study requirements had not been met as the teachers who had planned the lesson did not attend its implementation.

**The mathematical focus of the planning team**

No clear reason was given for the choice of topic for either research lesson. Furthermore, when the HOD introduced the topic for the Grade 10 research lesson
as Time graphs, a pre-service teacher asked why they were using a Grade 12 textbook to plan a Grade 10 lesson. After TB1 checked the new syllabus and confirmed that this was a Grade 12 topic, the HOD commented that time graphs were in Grade 10 in the old syllabus and said the team should go ahead with the planning the lesson for Grade 10. While the objective for lesson 1 was stated as students being able to calculate average speed, time and distance, discussion during the planning session and evidence from the lesson plan, suggests that students were expected to participate in discussions, be guided to develop the formula for speed, and provide their own examples of units related to speed.

The teacher delegated to teach lesson 1, TB1, planned detailed notes to write on the chalkboard. In these notes, 900 m is converted to 9/10 km and 1/30 hr is converted to 2 minutes using a relatively complicated algorithm based on using scalar operations within measure spaces to solve proportionality problems.

The objectives for lesson 2 were stated as students being able to solve linear inequations and draw graphs of linear inequations. Planned student activity was restricted to answering questions, listening to the teacher and asking clarifying questions, copying examples, and attempting to answer questions on the board and in their notebooks. The lesson plan suggested that the conclusion should use a chart to emphasis the main points when dealing with inequalities.

**The mathematical focus of the teacher during the research lessons**

During the introduction to lesson 1, the teacher, TB1, focussed on the concept of speed and how to calculate average speed – although at no stage is there any recognition of the difference between “speed” and “average speed”. The two tasks which the teacher demonstrated involved a simple calculation of average speed, although one required a conversion of time from minutes to hours. However, the task the teacher asked students to complete was conceptually much more difficult, involving both a conversion of distance and a transposition of the formula for average speed. When the second teacher, TB2, re-taught the lesson, students worked in groups to solve a much simpler problem during the lesson development phase and presented their solutions verbally to the class.

TB1, who had not taken part in the planning for lesson 2, taught the lesson. The focus for the lesson was on moving from solving linear equations to introducing the concept of inequalities and finding graphical solution strategies. When re-
teaching the lesson, TB1 used only examples involving one variable, unlike in the original lesson where he used both one and two variables.

The mathematical focus for students during the research lessons

Given the fact that, apart from on one occasion, the only observers were the HOD and the two pre-service teachers, it is difficult to find evidence about student thinking during the research lesson. However, one pre-service teacher observed that the majority of students whose books he had marked faced difficulties in changing the subject of the formula for speed. The HOD agreed and pointed out that it would have been better to provide the formula for time and distance earlier in the lesson.

Opportunities offered by the lesson studies observed

While a number of teachers attended the planning sessions – particularly for lesson 1 – across the teaching and re-teaching of the two research lessons observed, only once did any teacher other than the HOD, the teacher teaching the lesson, and the two pre-service teachers attend the lessons. Even this one teacher was “excused” from the revision session following the lesson they had observed and the HOD, the teacher teaching the lesson, and, sometimes, the two pre-service teachers were the only participants in the revision sessions and post-lesson discussions. This severely limited the opportunities for teachers other than the pre-service teachers and the teacher teaching the research lesson to develop professionally.

However, for the pre-service teachers involved there seemed to be a number of opportunities for professional development as well as to contribute to the professional development of the other teachers. For example, during the planning session for research lesson 1, it was one of the pre-service teachers who pointed out that the topic for the Grade 10 lesson was now in the Grade 12 syllabus, which prompted the planning team to consult the syllabus and confirm that this was the case. During the revision session for lesson 1, pre-service teachers also suggested that the teacher should not state the formula for speed but ask students to state it and that the chart was supposed to show the formula for distance and time in addition to the formula for speed. One of the pre-service teachers, when asked what they had learned after lesson 2 pointed to their increased understanding of how
to introduce the mathematical content, while the other commented on the need to allow students to participate more.

The revision sessions and the post-lesson discussions also offered opportunities for professional development for the teachers of the lessons – especially the feedback from the HOD in the one-on-one hour-long revision session she held with TB1 after the teaching of lesson 2. During the revision session for lesson 1, pre-service teachers also suggested that the teacher should not state the formula for speed but ask students to state it and that the chart was supposed to show the formula for distance and time in addition to the formula for speed.

6.4 School C: Lesson study cycles 1 and 2

School C is a girls’ boarding public school (Years 8-12) in Central Province with enrolment capacity of 250 students. The school was new, having first opened in 2014, and enjoyed the privilege of enrolling the top achieving girls from around the country.

Lesson study was introduced in School C in 2014, two years before the data collection took place. School C was invited to participate in the study at the request of the Permanent Secretary for the Zambian Ministry of Education, as the Deputy Headteacher was a member of the Zambian Kyōzaikenkyū team (KK Team) for science. As stated in Section 2.3.4 (African countries) of this thesis, the KK team had been working as core technical personnel for extending lesson study to all schools in Zambia and improving of mathematics and science lessons. The Deputy Headteacher had learned about lesson study through JICA lesson study training workshops in Zambia and Japan, and, as a member of the KK Team, she had also been attending international conferences on lesson study, such as the World Association of Lesson (WALS) conference.

The school was relatively well staffed with trained teachers, who mostly had undergraduate degrees. The student-teacher ratio was 25:1, a low ratio compared with most secondary schools in Zambia.

School C has better facilities than most public schools in Zambia. For example, students had access to computers and Internet as shown in Figure 6.61.

Furthermore, the School C faced some challenges implementing lesson study activities. These challenges included leaving classes unattended when
teachers are participating in lesson study, and some teachers assigned to participate in other school activities or off school activities when they are supposed to participate in lesson study. CC stated that:

On the actual date the teacher will be too busy and would even attend other workshops outside the school. Meanwhile, that was the key person for lesson study. As result, we would fail to implement that lesson study on the actual day that was planned. It brings a lot of re-scheduling [of] the activities

Figure 6.61. Students had access to computers at School C

To mitigate against the impact of leaving classes unattended, the School administrators had decided that teachers should conduct lesson study activities after school hours, with CC stating:

“There are certain groups that are too big and when we are doing the CPD it will mean all the teachers will have to leave their classes and attend one class where they will be having a demo lesson or a revised lesson. Therefore, what we have done is our CPD implementation will be done after the ninth period in our school timetable. That will be after 14:40 because children have what we call active prep from 14:40 to 16:00. That is what [we are] doing this term and I think we are doing fine. (CC).
6.4.1 Lesson study cycle 1

The research lesson for cycle 1 took place in Grade 9, on the topic of Profit and Loss.

The lesson study cycle was implemented in four days. Planning was done on day one and teaching on day two. On day three the teachers reflected and revised the lesson. The revised lesson was re-taught on day four and the post-lesson discussion took place on the same day.

Social and Commercial Arithmetic was a Grade 9 subtopic under the topic, Number systems in the New Syllabus. The students were expected to solve problems involving profit and loss, compound interest and hire purchase. Further to this, students were expected to understand the terms: foreign currency, premium, dividend, depreciation, value added tax, and income tax.

Planning research lesson 1

As can be seen in Figure 6.63, planning the research lesson took about 1 hour and 16 minutes. Six out of the eight teachers in the Mathematics Department (including the HOD) planned the research lesson (see, Figure 6.62). Planning was done during the last teaching period of the day, from 3.30 am to 4.45 pm, contrary to the suggestion by the Implementation Guidelines that, teachers should hold such meetings outside of teaching time (MOE & JICA, 2010b, p. 19).

In was decided beforehand that Teacher TC3 was going to teach the lesson. The team did not have a draft lesson plan.

Figure 6.62. The planning team for Lesson 1
Figure 6.63. Transana Episodic Keyword Map Report for planning for lesson 1 at School C
Lesson goals

One goal of the research lesson that was stated under the lesson rationale was that students would appreciate the lesson and apply the learnt concept in real life. Appreciating profit and loss is one of the educational values of the lesson stated under the last column.

The team also linked stated that the current lesson was the 5th lesson out of 8 lessons on Social and Commercial Arithmetic. However, the team did not discuss how the current lesson was linked to the 7 lessons. The team further stated the lesson objective as follows: After the discussion of profit and loss, pupils should be able to differentiate and calculate profit and loss.

Lesson introduction

The team decided that the lesson should be introduced during the first five minutes by TC3 posing the following question: Mrs Mokola bought a bag at K250 and sold it at K300. Did she gain money or lose?

The teachers expected students to give verbal answers. It was expected that answers from the students would include the words “gained” and “made profit”.

Lesson development

The team decided that TC3 should prepare a chart showing the formula for profit and loss, display it in class, and allow students to ask questions if they were not clear.

In Figure 6.64 from the planning session, TC2 stated that some students would be challenged if TC3 used 250 as cost price and 300 selling price first to calculate profit and later use 300 as cost price and 250 as selling price to calculate loss. According to TC2, using the same numbers (250 and 300) to calculate profit/loss would confuse some students, stating, “Why don’t we choose different numbers to calculate loss? Let’s say, we use 400 as selling price and 500 has cost price”. However, TC3 said that she did not see any problem, stating, “Students will be told the principle that when the selling price is lower than the be cost price than to is a loss. So, I don’t see any confusion”.


The team decided that TC3 should tell the students that negative numbers denoted a loss.

The team decided that TC3 should give students a question from the textbook and invite some students to calculate their answers on the chalkboard. TC2 advised TC3 to have worked out the answer already because students would demand the correct answers from her after they had attempted the question. Figure 6.65 shows the team carefully considering the questions under Exercise 1 on page 154 of the Zambia Basic Education Course (ZBEC) Maths 9 Students’ Book (MOE, 2004). They chose question 2.
After choosing the questions, the team decided that, after some students have completed their calculations on the chalkboard, TC3 should facilitate a discussion of the answers and comment on challenges students faced.

Lesson evaluation

The team decided that TC1 should ask students to attempt Question 4 from Exercise 1 on page 154 of the Zambia Basic Education Course (ZBEC) Maths 9 Students’ Book.

Lesson conclusion

The team decided that the conclusion should last five minutes. TC3 should review the challenging parts of the question and gives students Question 8(a) as homework.

As can be seen in Figure 6.63, the team did not discuss what observers would be doing during the teaching of the lesson.

The resulting lesson plan is shown in Figure 6.66.
LESSON PLAN

Ms. Ziba N
DATE: 19.05.15

CLASS: 7 II
N.O. OF PUPILS: 24
PERIOD: 9
DURATION: 40 min

SUBJECT: **Maths**

**TOPIC:** Social and arithmetic

**SUB TOPIC:** Profit and Loss

**RATIONALE:**
1. **Profit and loss**
2. Appreciate the lesson and apply the learnt concepts in real life.
3. Demonstrate language 1 discussion.
4. Set out of 8.

**SPECIFIC OUTCOME(S):**
After the discussion on profit and loss, students:
- Differentiate and calculate profit and loss correctly and within time.

**PRE-REQUISITE KNOWLEDGE AND SKILLS:**
- Percentages
- Four Basic Operations
- Equations & Ratios

**TEACHING AND LEARNING MATERIALS:**
- A chart on profit and loss is calculated
- Bread, rule
- A hand bag

**LESSON DEVELOPMENT**

<table>
<thead>
<tr>
<th>Stage &amp; Time</th>
<th>Teaching activities</th>
<th>Learning activities</th>
<th>Learning points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRODUCTION</strong></td>
<td>Mrs. Moringa bought a toy for K150 and sold it at K300. Did she gain or lose money or lose vice versa.</td>
<td>Verbally</td>
<td>Profit or loss</td>
</tr>
</tbody>
</table>

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Figure 6.66. The lesson plan for Lesson 1 for School C
Teaching research lesson 1

All six teachers plus the Deputy Headteacher attended the teaching of the lesson. As can be seen in

Figure 6.68, research lesson 1 lasted 22 minutes instead of 40 minutes because the lesson started late due to late arrival of the teacher, TC3, who had fallen ill, although she still taught the lesson.

Lesson introduction

During lesson introduction TC3 apologised to the students for her low voice because she was ill, stating, “My voice is very low because I have a cold”. She then wrote the following question on the board and displayed the chart for profit and loss formula on the board (Figure 6.67).

A carpenter spends K40 to make one school desk. A Headteacher of a school buys it at K55.

(a) How much profit does the carpenter make?
(b) What is the percentage profit?

![Chart on Profit and Loss]

Figure 6.67. The chart on profit and loss displayed by TC3 during Lesson 1

TC3 explained the chart, empathising the difference between profit and profit percentage, and between loss and loss percentage. TC3 then asked the students to attempt the question individually.
Figure 6.68. Transana Episodic Keyword Map Report for teaching lesson 1 at School C
Lesson development

The teacher asked the students to find the solutions to questions (a) and (b). As the students were solving the problems, the teacher went around checking their work. Later, she invited two students who volunteered to solve questions on the chalkboard as shown in Figure 6.69.

Figure 6.69. A student writing her solution on the chalkboard

For question (a), the first student subtracted K40 from K55 and wrote the answer as K15. The student then explained to the class that to get the profit you have to subtract the cost price from the selling price.

The second student attempted question (b). She divided 15 by 40 and multiplied by 100. She asked her friends to give her the answer for 150 divided by 4 and wrote 37.5%. No one explained why this would give the percentage profit. Finally, the teacher reminded students that K15 was the actual profit, not the percentage profit. TC3 advised students that when they find the percentage profit with decimals, it would be better not to round off the decimals.

Lesson evaluation

The teacher wrote the following question as an exercise for students:

A tailor agreed to make and sell a curtain to his customer for K900. However, because the price of material had gone up, it cost him K1000 to make the curtain. What was his (a) actual loss, (b) percentage loss?
The students worked individually while the teacher shared notes (answers to the question) with some observers.

As shown in Figure 6.70, three observers walked around the class marking students’ books and helping those who had difficulties.

Figure 6.70. Observers and the teacher marking students’ work

The rest of the time all the observers had remained in the seats, observing TC3 as she presented the lesson. While some observers were marking students’ books, other observers remained in their seats (see, for example, Figure 6.71).
Figure 6.71. Two observers remained in their seats while some marked books

Conclusion

The teacher ended the lesson by thanking all students for their participation. There was no further conclusion to the lesson.

Revising research lesson 1

The team held the session for reflecting on the effects of the lesson and revising the lesson immediately after the research lesson ended. The HOD chaired the lesson revision. In addition to the six teachers, the Deputy Headteacher attended the session. As can be seen in Figure 6.72, the team spent 34 minutes revising the lesson.

It is clear from Figure 6.63, that much of the discussion addressed the challenges faced by TC3 and, to a lesser extent, students. It also addressed the goals in terms of lesson objectives, as well as the lesson introduction, and observers’ comments about selected students.

The HOD asked TC3, the teacher who taught the lesson, to speak first on her experiences, starting from the lesson introduction to the end of the lesson. TC3 apologised that she did not do her very best presenting the lesson because she was ill, stating, “I was feeling really bad because of the cold and I had to force myself to complete the lesson”.

The HOD asked the observers to comment. The Deputy Headteacher stated that the team should not have allowed a teacher who was ill to teach the lesson, commenting that “You planned the lesson as a team, implying you all own the lesson. Therefore, any of you could have taught it instead of the teacher who was ill”.

The challenges faced by the observers, shown by the two relevant bars in Figure 6.72, related to what TC2 called “little co-operation among the team members”. TC2 stated “We all know that we needed to help mark the students’ exercise. But some of our colleagues remained seated. It seems to me there is little co-operation when it comes to marking the books. Maybe the Deputy Head can comment on this”. In response, the Deputy Headteacher asked TC5 why she did not participate in marking the students’ books, to which she replied “When you taught
us lesson study, you had emphasised that our role is to observe and not to talk to the teacher or students during the lesson. So, that’s why I remained in my chair”. The Deputy Headteacher responded, “Indeed, your role is to see how the lesson unfolds in class. You are not supposed to mark the books nor explain the concepts to students”.

The bars in Figure 6.72 on the challenges faced by the students relate to the soft voice projection from TC3. According to TC2, the soft voice of TC3 had affected the students’ response to the lesson. The Team decided that TC1 should re-teach the revised lesson.

The four bars along the row labelled Goals (current lesson) in Figure 6.72 relate to the question of the extent to which the lesson objectives had not been achieved. The team had stated the lesson objective as: After the discussion of profit and loss, pupils should be able to differentiate and calculate profit and loss.
Figure 6.72. Transana Episodic Keyword Map Report for revising lesson 1 at School C
TC3 stated that the lesson period, 40 minutes was too short to achieve the lesson objective – in fact, the lesson only lasted 22 minutes. However, TC3 did not justify her claim with what she had observed from the students books she had marked. Furthermore, the HOD said that TC3 had spent a lot of time writing the questions on the board, advising, “Maybe next time we should consider printing the questions in advance on student work sheets so that we save time”. The team welcomed her idea, with TC1 stating, “That’s a good idea so that students will have more time to solve the questions”.

The team decided that TC1, who would be teaching the revised lesson, should incorporate the points discussed in the revised lesson plan. The team decided that the lesson plan could be revised the following day. The HOD thanked the teachers for participating in lesson study and the Deputy Headteacher for observing the research lesson and for correcting the misconception regarding observers marking students’ work. The Deputy Headteacher thanked the team, stating, “I would have loved to observe the teaching of the revised lesson. However, I have an equally important meeting to attend in Lusaka. Don’t hesitate to seek clarification on any issues you are struggling with in implementing lesson study”.

Re-teaching research lesson 1

TC1 taught the revised lesson because TC3, the teacher who taught the first lesson, was still ill. Except for T3 and the Deputy Headteacher, all of the teachers who attended the research lesson observed the re-taught lesson. The Keyword Map in Figure 6.73 summarises the quantitative aspects (duration of each activity) and qualitative aspects (what was addressed) of the re-taught lesson.

The lesson was taught in 42 minutes. In terms of the lesson flow, more time was spent on lesson evaluation – students answering the questions in their books and TC1 going around marking students’ work. The bars under Pupil activity show that students answered the questions verbally; found written solutions; and twice made presentations to the class, one during the lesson development and the other during the lesson conclusion. However, the map shows that students did not discuss the solutions their colleagues presented to the class.
Figure 6.73. Transana Episodic Keyword Map Report for re-teaching lesson 1 at School C
Lesson introduction

Figure 6.74. TC1 introducing the revised lesson

In the introduction, the teacher used the bag shown in Figure 6.74 to pose the question: *Mrs Mokola bought a bag from Livingstone at K250 and sold it at K300. What happened?*

A student answered that Mrs Mokola made a profit of K50. After that, the teacher wrote the topic and subtopic on the board and asked students to define profit and loss. The students had a good understanding of the two concepts. The teacher wrote the following definitions on the board:

- **Profit** = gain after business; **Loss** = reduction in capital.

Lesson development

Later, TC1 asked students to state the formula used for calculating profit. A student stated, “I think profit equals selling price minus cost price”. Another student stated the formula for calculating loss as “loss = cost price – selling price”.

The teacher introduced the notations CP (cost price), SP (selling price), P (profit), and L (loss). He also pinned a chart showing the formula for profit and loss on the board (see Figure 6.75).

TC1 used charts to introduce two more questions and students went to the board to solve them. The teacher commented that it was very important to identify the selling and cost prices.

TC1 gave the class the following two questions as an exercise to solve individually.

1. A trader bought 25 boxes of lollipops for K525. Each box contains 100 lollipops. Calculate his profit if he sold each lollipop at 25n.
(2) A carpenter agreed to make and sell a bed to his customer for K900. However, because the price of wood had gone up, it cost him K1000 to make the bed. What was his loss?

![Figure 6.75. TC1 displaying the chart on profit and loss](image)

Figure 6.75. TC1 displaying the chart on profit and loss

As Figure 6.76 shows, the teacher walked between desks checking students’ work.

![Figure 6.76. The teacher checking students’ solutions](image)

Figure 6.76. The teacher checking students’ solutions

Lesson conclusion

The conclusion involved inviting one student to solve question (1). The student (shown in Figure 6.77) solved the question on the chalkboard, while asking for verbal responses from the class.
The student started solving the question by writing the total cost price of 25 boxes of lolly pops as K575. She calculated the selling price of one box of lolly pops by multiplying the number of lolly pops in one box (100) by the selling price of each lolly pop (25n) and got 2500n. She then found the selling price of all the 25 boxes by multiplying 25 (number of boxes) with 2500n (selling price of each box) and got 62 500n (62500 ngwee). She told the class that because the total cost price for the 25 boxes of lolly pops was in Kwacha (K575), the total selling price should be converted into Kwacha to calculate the profit. She converted 62 500n to Kwacha and got K625. She finally subtracted the total cost price from the total selling price (K625 – K575) and got K50 as profit.

After the student presented her solution, the class did not comment on her solution. TC1 reminded the class that it was necessary to convert ngwee into Kwacha to calculate profit or loss. After this TC1 wrote the homework question shown in Figure 6.78 and asked pupils to copy it.
While students were writing the homework question into their books, TC1 thanked them for their active participation in the lesson, and started, “We end here for today”.

The observers remained in their seats during the lesson. Unlike during the first lesson, the observers did not mark students’ books, but they also did not observe what students had written.

Post-lesson discussion

The post-lesson discussion was held immediately after the lesson. All six teachers attended the post-lesson discussion chaired by the HOD. The Deputy Headteacher was absent this time. The post-lesson discussion lasted just 3 minutes. It is clear from the Transana Episodic Keyword Map Report, which is not reproduced here, that the discussion focussed on three topics: challenges, goals, and student activity.

The HOD said that the challenge students faced during the first lesson regarding the low voice of the teacher was not there in the re-taught lesson:

Unlike the first lesson where students had problems hearing what the teacher was saying because of her low voice, the teacher in second lesson was heard clearly by students. Mr … your voice was loud enough. (HOD)

She further asked the team members to state whether the lesson goal had been achieved. The team members agreed that the lesson objective had been achieved, with TC5 stating that many students were able to solve the exercise within limited time given to them.

6.4.2 Lesson study cycle 2

Lesson study cycle 2 was for Grade 11 on the topic of exponents and logarithmic functions, the third topic for Grade 11 in the New Additional Mathematics Syllabus (MESVTEE, 2012). The topic outcomes, knowledge, skills and values are shown in Table 6.1.
Table 6.1. Exponents and logarithmic function in the New Mathematic Syllabus

<table>
<thead>
<tr>
<th>TOPIC/ THEME</th>
<th>SUB-TOPIC</th>
<th>SPECIFIC OUTCOMES</th>
<th>• KNOWLEDGE</th>
<th>• SKILLS</th>
<th>• VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.3 EXPONENTS AND LOGARITHMIC FUNCTION</td>
<td>11.3.1 Exponents</td>
<td>12 Sketch graph of $y = a^x$ where $a&gt;0$, $a \neq 1$ and the graph of $y = e^x$.</td>
<td>• Graphs of the form $y = a^x$ and $y = \log a^x$.</td>
<td>• Sketching</td>
<td>• Logical thinking</td>
</tr>
<tr>
<td></td>
<td>11.3.2 Logarithms</td>
<td>13 Express exponential function as a logarithmic function.</td>
<td>• Exponential function</td>
<td>• Expression</td>
<td>• Abstract thinking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14 Sketch graphs of $y = \log a^x$ where $a&gt;0$, $a \neq 1$ and graph of $y = \ln x$.</td>
<td>• Logarithms function</td>
<td>• Solving problems</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 Solve problems using laws of indices and laws of logarithms.</td>
<td>• Laws of indices</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>11.4 VECTORS IN TWO DIMENSIONS</td>
<td>11.4.1 Vectors</td>
<td>12 Definition of vectors.</td>
<td>• Addition and subtraction</td>
<td>• Calculations</td>
<td>• Interpretation and application</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13 Use notation $(a) \cdot (b) \cdot \tilde{p}, a \cdot \tilde{b}$</td>
<td>• Multiplication</td>
<td>• Computation</td>
<td>• and application</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14 Add and subtract.</td>
<td>• Position vectors</td>
<td>• Indentification</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 Multiply vectors by scalar.</td>
<td>• Unit vector</td>
<td>• Differentiate</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16 Find position vector of a point.</td>
<td>• Dot product</td>
<td>• Compare</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17 Apply position vectors in calculations.</td>
<td>•</td>
<td>• Apply</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18 Find unit vector.</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19 Use (scalar) product of two vectors.</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 Use dot product to find angles between two vectors.</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
</tbody>
</table>
Planning research lesson 2

The planning session for research Lesson 2 took place on the day before the lesson was taught. Six teachers, shown in Figure 6.79, attended the session. The HOD stated that TC4 could not attend the panning session because she was attending a workshop in Lusaka. The HOD welcomed TC6, stating, “He did not participate in previous lesson study cycle because he was ill”. TC 2 was assigned to teach research lesson 2.

![Image](image_url)

Figure 6.79. School teachers planning research lesson 2

The quantitative and qualitative aspects of the planning session based on the keyword used for coding video data are summarised in Figure 6.80. The bars beside the keywords Goals (Unit and Current lesson) relate to the time spent discussing the lesson goals. The team spent about 30 minutes formulating the rationale for the lesson; discussing students’ pre-requisite knowledge and skills; formulating the lesson objective; and considering the teaching materials for the lesson. The team spent the remaining time discussing the lesson flow – how to introduce and develop the lesson, the exercise to give students for evaluating the lesson, and the activities for concluding the lesson.

The points of discussion for student activities focussed on verbal answers from students, attempting the exercise, and presenting to the class. The team considered the resources to be used – the textbook and the teaching aid in terms of a chart. Furthermore, it can be seen from Figure 6.80 that teacher activities were discussed more than students’ activities. The team also discussed observer activities. Details of the planning activities are presented below.
Figure 6.80. Transana Episodic Keyword Map Report for planning lesson 2 at School C
Lesson goals

The team started the planning by considering the lesson rationale. They listed the following as the rationale for the lesson. The HOD suggested that the content section of the rationale should be, “Enable students to express exponential functions into logarithmic functions”. TC5 proposed that the value rationale should focus making students appreciate logarithmic functions in solving real-life problems. The team were faced with the problem of coming examples of real life situations where these functions are used. In Figure 6.81 TC1 is reasoning with TC1 to come up with real life situations where exponential and logarithmic functions are used.

Figure 6.81. TC2 and TC1 considering educational value of exponential and logarithmic functions

TC5 stated that engineering was one of the examples where these functions were used. However, this was not mentioned in the two lessons – research and retaught lessons.

When considering the Method rationale, TC2 asked the team to make him understand what demonstration as a method meant. TC3 stated that it involved the teacher showing students how to perform a certain activity, such as plotting a graph. The HOD asked whether inviting students to solve a task on the board constituted demonstration method. TC2 answered:

In think, that is guided learning because the student would not solve a problem from the blues. The student would use the information you have presented to solve the problem. For example, you can write the
topic on the board on exponential functions and call a student to solve
a problem. Somehow, you have to guide the student.

TC5 stated that the process described by TC2 would fall under inquiry
method, clarifying that a student when asked to solve the problem before the class
usually solicited views from their colleagues. The team members conclude that they
did not understand clearly what was exactly was involved in each teaching method,
with TC1 suggesting,

In future, we need CPD on teaching methods. You can write the method
you are going to use on the lesson plan and yet in reality you are using
a different method altogether.

The HOD agreed, took note of the suggestion and promised to make a
follow up. The team reverted to the method rationale and suggested that following
be involved on the lesson plan: discussion, engage in problem-solving and guided
discovery. With guided discovery, TC2 explained that when students faced challenges the teachers could guide them by asking questions that give them hints.

Further, the team formulated the outcome of the research lesson or lesson
objective as follows: By the end of the lesson, students should be able to express exponential functions into logarithmic functions with less difficulty. TC2 emphasised as follows:

You cannot teach where everyone solves everything very well. There
will some who will have challenges. But these challenges will be less.
But if there are many students who challenges it means you have to assist a lot of students.

TC2 asked the team for prerequisite knowledge. TC3 said indices and algebra. TC2 mentioned that equations were necessary. The team did not discuss further the prerequisite knowledge. Regarding resources to use, the team agreed that the chalkboard and a chart would be sufficient, with HOD stating that some Ministry senior officers do not approve of teachers considering a chalkboard as a teaching material.

Lesson introduction

Before the team discuss the content of lesson introduction, TC2 stated that
lesson introduction should not take too much time because the lesson would be
taught in one period (40 minutes). TC5 proposed that five minutes should be enough for introducing the lesson and the team members did no objection. On how best to introduced, TC6 proposed that TC2 should write an exponential function on the board and ask students to name give the other names the index, stating, “They should first know what an exponent is”. HOD asked TC2 to select one exponential function from the textbook for lesson introduction and TC2 selected \( a^x = y \). In Figure 6.82 the team has given TC2 time to complete the introduction section of the lesson plan.

![Figure 6.82. TC2 completing the Introduction section on the lesson plan](image)

The HOD said that TC2 should explain the relationship between exponential functions and logarithmic functions in the introduction and allow students to ask questions for clarification.

Lesson development

TC3 suggested that enough time should be spent on lesson development, stating, “On our lesson plan template lesson development and evaluation are combined, so we need to allocate more time”. TC1 said the lesson template need to be formatted so that we include the section on lesson evaluation. The team agreed that the lesson development should last 30 minutes. Further, the team decided that TC2 should write the following two questions from the textbook on the chalkboard and show students how to express exponential functions into logarithmic functions.

\[
\text{Write in logarithmic form} \quad (a) \ x^3 = 10, \ (b) \ 2^{-2} = \frac{1}{4}.
\]

TC1 said that the question is good because the second part has a fraction
and a negative index. TC2 said he would ask a student to solve (a) before the class and as the class to solve (b) in pairs, adding, “I will make clarifications were pupils face challenges”.

TC5 suggested that TC2 should display a chart (see, Figure 6.85) with an example of an exponential expression with its logarithmic form. TC2 responded:

We can show them the expression $a^x = y$ and its logarithmic form $log_a y = x$. I will construct the chart after this planning meeting.

The HOD told TC2 to also write the above two expressions he had mentioned on the lesson plan. TC5 suggested that during the research lesson TC2 should not display the chart at the beginning of the lesson but later when the students have stated what they understand about the exponential and logarithmic functions. TC1 reminded TC2 that the prints on the chart should be large enough so that students at the back of the class could see the prints on the chart clearly.

The team decided that after showing students how to complete the two tasks, TC2 should write the following question on the chalkboard and ask students to work on the exercises individually. TC3 said that TC2 should find time to mark the work of students, especially while they are working on the questions, adding, “We should probably give them one question from the textbook”. TC2 stated that he wanted to give students question 4 from the exercise in the textbook, stating, “This question will be challenging to some pupils. I believe all the students should not easily solve the question. I should be challenging to the few students”.

Write in logarithmic form (a) $10^{-3} = 0.001$, (b) $16^x = 8$

The HOD said the question was good and advised that TC2 should walk between desks, helping those with difficulties and marking the books. TC5 stated:

We expect him (TC2) to walk around the class marking the students’ books. You have a big task here because we are not going to help you mark the students’ work. The Deputy Headteacher was clear about our role when observing the lesson. (TC5)

TC2 responded that he would do his best to walk around the class and mark students’ work, stating:
I think I can manage to check their books. Grade 11K has 29 students only. It’s not like the school where I was first posted. I had 61 students in a class. It was challenging to check students’ books in class. (TC2)

Lesson conclusion

The team decided that the lesson conclusion should last 5 minutes. TC2 should ask a student to solve a challenging problem in front of the class, while the rest of the class watch the student solving the problem.

As can be seen in Figure 6.80, the observer activities were discussed. This relates to the comment by TC5 above. The team did not discuss the use of the lesson plan or checklist, observing selected students, and recording the observations.

The lesson plan produced during this planning session is shown in Figure 6.83.
## LESSON PLAN

**TEACHER'S NAME**

**CLASS** 11K2

**N.O. OF PUPILS** 29

**PERIOD** 10

**DURATION** 40 MIN

**SUBJECT:** ADDITIONAL MATHEMATICS

**TOPIC:** EXPONENTIAL AND LOGARITHM FUNCTION

**SUB TOPIC:** THE LOGARITHMIC FUNCTION

### RATIONALE
- Exponentiating functions into logarithmic functions
- Understanding 

### SPECIFIC OUTCOME(S)
By the end of the lesson, PSBA7 students will be able to:

### PRE-REQUISITE KNOWLEDGE AND SKILLS
- Indices, algebra and equations

### TEACHING AND LEARNING MATERIALS
- Chart, chalk board

### LESSON DEVELOPMENT

<table>
<thead>
<tr>
<th>Stage &amp; Time</th>
<th>Teaching activities</th>
<th>Learning activities</th>
<th>Learning points</th>
</tr>
</thead>
</table>
| **INTRODUCTION** | Pupils state the other name of index, power in the given examples. $x = y^z$, which is $x = y \cdot y \cdot y$ up to power. 
5 mins. | Pupils state the other name of index as exponent. 
| | | |
Figure 6.83. The lesson plan for research lesson 2 at School C

**Teaching research lesson 2**

The lesson was taught by TC2 on the day after the planning session. All of the teachers who planned the lesson observed it. Figure 6.84 summarises the activities the lesson addressed under each keyword, and the time spent on these
activities. As shown by the top bar, the research lesson lasted 39 minutes. The introduction lasted 7 minutes; the lesson development, 20 minutes; and the evaluation (whose activities are stated under lesson development section on the lesson plan) took 11 minutes. The conclusion lasted lesson about two minutes.

The bars in the observer activities rows relate to the note taking by some observers. The bars for pupil activity show that students’ activities were answering verbal questions, solving written problems, and presenting before the class.
Figure 6.84. Transana Episodic Keyword Map Report for teaching lesson two at School C
It can also be seen that the chart was used during the lesson. The details of the planning session are presented below.

Lesson introduction

The teacher introduced the lesson by asking students to state another name for the index or power of a in the expression $a^2 = y$. One student answered that another name was “exponent”. TC2 asked the opinion of other class members, who agreed with the answer. TC2 then displayed the chart shown in Figure 6.85.

![Figure 6.85. A chart on exponential and logarithmic functions](image)

TC2 explained that the expression on the left hand side of the chart ($y = a^x$) was in exponential form, and that the expression on the right-hand side of the chart ($\log_a y = x$) was in logarithmic form. TC2 wrote $3^2 = 9$ on the board and asked students how it could be expressed in logarithmic form. Before the students could answer the question, one student asked TC2, “What is logarithmic function?” TC2 asked the students to answer the question asked by their colleague, stating, “Who can tell us the answer?” A student shown in Figure 6.86 raised her hand and answered, “It is the inverse of an exponential function”.

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TC2 agreed with the student and added that there was another way of explaining it:

Imagine you are given a 7 and you told to write it in inverse form, it would be 1/7. In other words, 1/7 is the inverse of 7. Similarly, when you are given an exponential function, \( a^x = y \), and you are told to write it in inverse, it means you have to express it in logarithmic form.

TC2 reverted to the question on how express \( 3^2 = 9 \) in its logarithmic form. A student shown in presented answer on the board as \( 2 = \log_39 \)

TC2 asked the student to explain to the class how she got the answer. She explained how she got the answer using the chart, stating:

Using the logarithmic form, \( x = \log_a y \), 2 becomes the subject of the formula. Therefore, 2 equal the \( \log_39 \).
TC2 asked the class to comment on the answer given by the student, and some students shouted, “Correct answer”. TC2 asked the class if they were ready to express exponential expressions into logarithmic forms, and the students answered that they were ready.

Lesson development

TC2 then displayed another chart shown in Figure 6.88 with two exponential expressions and told the class that question (a) will be solved as a class and after which students would solve question (b) in pairs.

![Image of a chart showing exponential and logarithmic functions with examples]

Figure 6.88. TC2 gave the class two examples of exponential expressions

TC2 asked for any volunteer to solve (a) before the class. A student shown in Figure 6.89 solved question (a) before the class stating,

We want to express this form, $a^x = y$, to the form $x = \log_a y$. Therefore, our expression $x^3 = 10$ will become $3 = \log_{x}10$. 
TC2 solicited comments from the class on the answer given by the student, and the class agreed that the answer was correct. TC2 then urge the students to attempt question (b) in pairs. One student as the name given to “a” in the expression \( x = \log_a y \). TC2 said that “a” was referred to as a base, stating, “We read \( x = \log_a y \) as log of \( y \) base \( a \).”

A student asked TC2 why they should be considered by expression exponential functions into logarithmic functions. TC2 answered that one of the reasons is to enable them to calculate the values of the variables.

For example, it is east to solve the expression \( 2^x = 8 \), but hard to solve \( 2^x - 7 \). Therefore, the second expression can be expressed in logarithmic form and then solved. Consider \( \log_3 9 = x \), which you cannot solve using your calculator. You can change it to exponential form and then solve it.

The class had no further question and TC2 did not follow on question (b) he had asked students to solve in pairs.

Lesson evaluation

Finally, TC2 as shown in Figure 6.90 wrote two questions for the class exercise on the chalkboard: *Write in logarithmic form (a) \( 10^{-3} = 0.001 \), (b) \( 16^z = 8 \).*
As shown in Figure 6.91, TC2 walked between desks during the lesson marking students’ books.

![Figure 6.91. TC2 marking students’ books](image)

Lesson conclusion

After the exercise was completed, TC2 invited a student (shown in Figure 6.92) to present her solution for question (b) for the exercise.

The student told the class that in the expression $16^x = 8$ there was a need to express them with the same number on both sides and she wrote $2^{4x} = 2^3$. She said if $2 = 2$ then exponents are also equal and wrote $4x = 3$. She made got the value of $x$ as $\frac{3}{4}$.

She the expressed $16^x = 8$ in logarithmic form as $\log_{16} 8 = x$. She substituted $x$ by $\frac{3}{4}$ and wrote $\log_{16} 8 = \frac{3}{4}$ as the answer. TC2 agreed with her. There was no further discussion of the solution presented.
Figure 6.92. A student presenting her solution to question (b) for the exercise

TC thanked the student for presenting her solution and informed the class that time was up for the lesson to end.

Observers

Observers sat at the back of the classroom (see, Figure 6.93). They did not interject, and some were taking notes. However, none of the teachers who were observing took video or photographs.

Figure 6.93. The observers seated at the back of the classroom
Post-lesson discussion 2

The team met immediately after the lesson for about three minutes and decided that the lesson objectives had been met. Therefore, they decided not to re-teach the lesson, with the HOD saying, “We do not need to re-teach the lesson because our lesson objectives have been met”.

6.4.3 School C Summary

This section summarises the implementation of lesson study as observed at School C.

School context

School C is a new, prestigious girl’s boarding school located in the Central Province of Zambia. The school was well resourced and attracted high achieving students. The school was included in the study at the request of the Zambian Ministry of Education due to the fact that the Deputy Headteacher was a member of the Zambian Kyozaikenkyu team (KK Team).

All of the participants from School C who were interviewed (the Head Teacher, HTC, the CPD co-ordinator, CC, and the two teachers, TC1 and TC2), commented that lesson study is driven by challenging topics or problems that everyone regarded as needing a solution. The CPD co-ordinator, CC, believed that lesson study was different from other CPD approaches and promoted levelling of understanding among teachers, as well as leading to more student-centred teaching.

However, both CC and HTC were concerned that some teachers only looked at the remuneration aspects of participating in lesson study (such as being provided with refreshments), while CC also claimed that newly graduated teachers were reluctant to attend lesson study because universities did not inform them about the need to participate in CPD once they were employed.

Teachers also commented on the lack of resources, such as teaching aids, to support lesson study, with even the textbooks pertaining to the new national curriculum not yet being available.

Implementing the lesson study cycles

School C had adopted a pattern of implementing each lesson study cycle over four days, with lessons being taught during the ninth period of the day when students usually had prep so that teachers did not have to leave their classes to attend.
Planning was done on day one and teaching on day two. On day three the teachers reflected and revised the lesson. The revised lesson was re-taught on day four and the post-lesson discussion took place on the same day.

Six of the eight mathematics teachers, including the HOD, took part in all phases of the two lesson study cycles.

In addition, the Deputy Headteacher also attended research lesson 1 and the revision session. However, she was unable to attend the revised lesson and post-lesson discussion as she had a meeting in Lusaka and she did not attend any sessions in cycle 2.

Both planning meetings took place during school hours on the day before the research lesson was taught. While both planning meetings lasted over an hour and the revision session in cycle 1 over half an hour, the final post-lesson discussion in cycle 1 lasted just 3 minutes. The revision session in cycle 2 also lasted just three minutes, with team members concluding that no revision of the lesson was necessary and so there was no revised lesson taught.

Some observers marked students’ books during research lesson 1, while others remained in their seats. The Deputy Headteacher reminded teachers that the role of observers was to see how the planned lesson unfolded in class and so they should not be marking students’ work. In the remaining class sessions (re-teaching of the revised lesson 1 and the teaching of research lesson 2) the observers remained in their seats.

The mathematical focus of the planning team

While the actual lesson plans produced by the planning teams for both lessons 1 and 2 might suggest a focus on correct answers and little emphasis on an understanding of the concepts involved or on students engaging in discussion, the hour-long planning sessions suggest something somewhat different.

For example, in lesson 1, the team engaged in robust discussion as to whether or not students would be challenged by the teacher using the same numbers in the two examples for profit and loss, while the planning team also agreed that TC3 should tell the students that negative numbers denoted a loss. Further they proposed that the conclusion should consist of going through challenging parts of the problems on the chalkboard while asking students to provide comments and engage in discussion.

While planning research lesson 2, the team decided to focus on making students appreciate the use of logarithmic functions in solving real-life problems for the “value rationale”. This led to the challenge of actually finding real-life situations where exponential and logarithmic functions are used. As was the case in lesson 1, the examples to be used were
carefully considered, with a teacher commenting that the use of \(2^{-2} = \frac{1}{4}\) as one of the examples for students to convert into logarithmic form was good because it contained both a fraction and a negative index. The HOD also asked the teacher to explain the relationship between exponential functions and logarithmic functions in the introduction.

**The mathematical focus of the teacher during the research lessons**

The mathematical focus for the teacher in both lessons corresponded to the focus of the planning team. However, it was obvious in all lessons that the teachers involved were not satisfied with students just getting the correct answers. Instead students were expected to give explanations for their answers. For example, when a student demonstrated her answer for expressing \(3^2 = 9\) in its logarithmic form, the teacher asked her to explain to the class how she got the answer. Her answer “Using the logarithmic form, \(x = \log_a y\), [and] 2 becomes the subject of the formula. Therefore, 2 equal the \(\log_3 9\)” demonstrated that students in these classes were expected to give complete, mathematically correct answers. In a similar vein, students in lesson 1 asked for verbal responses from the class. However, explanations were not always provided as to why particular calculations were used and students were not always asked to comment on answers.

**The mathematical focus for students during the research lessons**

It is difficult to find evidence about student thinking from the post-lesson discussions as, once again, they rarely focussed on students’ thinking (probably due to lack of evidence collected by the observers) and were often extremely short.

However, the fact that the students who were asked to present their solutions before the class in lesson 2, were asked to explain their thinking, and that they regularly included their classmates in their presentations, suggests that students expected to look beyond the “correct answers”.

In addition, the fact that some students asked the teacher in lesson 2 questions such as “What is a logarithmic function?” and why they needed to express exponential functions in logarithmic form, suggests that students were looking beyond just getting a correct answer. It also demonstrates the wide range of prior knowledge in the class and emphasises the need for the planning team to have anticipated student solutions when planning the lessons.


Opportunities offered by the lesson studies observed

Lesson study cycles observed at School C offered a number of opportunities for teachers to develop professionally. Teacher commitment to lesson study seemed high, with the HOD informing the team about the whereabouts of the teachers who were not attending the lesson study sessions. Such commitment might guarantee the continuity of lesson study at School C.

The lesson plan template also provided other opportunities for helping teachers to deepen their knowledge. The teachers were required to address the section on lesson rationale on the template, suggesting that teachers were supposed to consult the New Mathematics Curriculum to clarify the position of the tasks in the curriculum and the educational value of the lessons.

During the planning session for lesson 2, teachers also discussed the section in the rationale addressing “method”. The teacher who was to teach the lesson asked for help in understanding what was meant by “demonstration”, which resulted in a discussion about the meaning of various other “methods” such as discussion, problem solving, inquiry and guided discovery. The team concluded that they did not understand clearly what was intended by each method and that they would like professional development on this aspect, which was duly noted by the HOD for future action.

The discussion about the objective that “students should be able to express exponential functions into logarithmic functions with less difficulty” included a valuable comment from the teacher of the lesson that “less difficulty” was a useful reminder that there was a range of prior knowledge in the class and that all students needed to be helped to meet the challenges they faced in learning a particular topic.

However, the lesson plan template did not provided opportunities for teachers to anticipate students’ solution as it had no column to state the anticipated solutions.

6.5 Conclusion

As discussed in earlier chapters, the Zambian Ministry of Education identified three main areas of mathematics education as requiring reform: (i) teacher-centred instruction, (ii) the mathematics curriculum, and (iii) continuing professional development of mathematics teachers (MOE, 1996). A series of attempts to reform the mathematics curriculum resulted in the New Mathematics Curriculum (Ministry of Education, Science, Vocational Training and
Early Education, 2012) implemented in all government schools.

The introduction of lesson study was intended to address the need for the continuing professional development of mathematics teachers and result in a shift from teacher-centred learning to more student-centred learning (MOE & JICA, 2010b). Lesson study was also intended to address challenges faced by teachers and students, including the teaching of challenging areas of the New Mathematics Curriculum, thus also contributing to the success of curriculum reform (MOE & JICA, 2010b).

Chapter 4 of this thesis presented the definition of lesson study by the Zambian Ministry of Education and how it was interpreted by the in-service providers, school administrators and teachers of mathematics. Zambian lesson study is defined and documented in the Ministry policy documents – the Implementation Guidelines and the Teaching Skills Book. The quantitative aspects defined include the number of lesson study that each subject department in government secondary schools should conduct every school term, the minimum number of teachers (three) to conduct lesson study, the duration of each lesson study cycle (at most five days), and the duration of each step in the cycle.

The qualitative aspects defined relate to the content of each activity, such as planning the research lesson, teaching the lesson and post-lesson discussion. For example, planning a research lesson involved the planning team discussing the draft lesson plan; discussing the lesson rationale, including the position of the lesson in the New School Syllabus; considering students’ prerequisite knowledge and skills; formulating the lesson objective; and discussing the lesson flow – lesson introduction, development, evaluation and conclusion. Planning the lesson flow involved teachers in formulating and discussing a pivotal question for introducing the research lesson; anticipating student solutions to the tasks; designing the comparison and discussion of students’ solutions; and discussing the lesson conclusion.

The Teaching Skills Book also gave detailed instructions on the role of the observers – for example, stating that “The lesson should be observed from the view of learning. The culture of sitting at the back by the observer is not allowed as one would not see the facial expressions on the face of the children. Walking around would help identify the actual skills learners have or do not have” (MOE & JICA, 2009, p. 33).

This chapter concludes with a brief discussion of the observations at the three schools participating in this study.

6.5.1 The school contexts

School A was a prestigious co-educational boarding school, drawing high-performing
students from all over the country. It had a relatively well-staffed mathematics department and a low student-teacher ratio. The school had relatively good facilities, such as chalkboards, and adequate instructional materials, such as student text books. In addition, the Teacher District Resource Centre was located within the school. Almost all of the mathematics teachers were involved in teaching afternoon APU classes, which provided them with extra income.

Lesson study was first introduced at School A in 2012 as part of the expansion of lesson study to all ten provinces in Zambia. The Head Teacher was a mathematics teacher, trained in lesson study by Japanese experts in Japan, Kenya and Malaysia. The CPD co-ordinator believed that teachers who participated in lesson study learned a lot, however he was concerned that there was a low level of interest among teachers, especially those whose students already achieved good results in mathematics.

School B was an urban day school, located in Central Province. It had a long history of lesson study, being among the first schools in Zambia to introduce lesson study in science in 2005. While the school was relatively well staffed, it had dilapidated infrastructure, with chalkboards in some classrooms almost impossible to write on. The average student-teacher ratio for the mathematics classes that participated in the observed lesson studies was 50:1, a low ratio compared to some secondary schools in Zambia, but higher than the ratio of 30:1 observed at School A.

The Head Teacher had learned about lesson study from a group of teachers who had been sent to Kenya where a lesson study program had been implemented. As a school with a long history of involvement in lesson study, its teachers were sometimes invited to facilitate lesson study at other schools. However, the Head Teacher was concerned that some teachers thought lesson study was a waste of time. At the time of the study, the CPD Co-ordinator was on extended leave, with the Deputy Headteacher acting in the position.

School C was a new, prestigious girl’s boarding school located in the Central Province of Zambia. The school was well resourced, with students having access to computers and the internet. The school attracted high achieving students and had a student-teacher ratio of just 25:1. Nevertheless, teachers commented on the lack of teaching aids other than “home-made” materials such as charts – for example projectors – to support lesson study, and the lack of textbooks pertaining to the new national curriculum.

The school was included in the study at the request of the Zambian Ministry of Education due to the fact that the Deputy Headteacher, who had learned about lesson study through JICA lesson study training workshops in Zambia and Japan, was a member of the Zambian Kyozaikenkyu team for science. However, the CPD Co-ordinator expressed concern
that newly graduated teachers were reluctant to attend lesson study because universities did not inform them about the need to participate in professional development once they were employed.

6.5.2 Implementing the lesson study cycles

While almost all members of the mathematics department at School A took part in all phases of the two lesson study cycles, each lesson study cycle was completed in just one day, with the planning taking place during the period preceding the research lesson. As a result of teachers arriving late, very little time was spent on planning, while the time for the actual lessons was also curtailed as the planning overlapped with the lesson time. The time spent on the lesson revisions and the post-lesson discussions was also very brief – in fact a total of just over half an hour was spent in the four sessions combined. While the HOD reminded participants to record their observations of the research lessons, he was the only person to do so and was also the only observer to walk around and look at students as they worked.

At School B, the planning took place on the day before the research lessons, with the planning sessions taking over an hour in both cycles. However, of the eight people who took part in the first planning session, three did not attend the research lesson nor the revision session, with one of these three non-attenders teaching the revised lesson. Only the HOD and two pre-service teachers attended the revised lesson. Not surprisingly, the HOD commented during cycle 1 that the lesson study requirements had not been met as the teachers who had planned the lesson did not attend its implementation. In the second cycle, only the HOD, the teacher who was to teach the lesson and two pre-service teachers attended the planning session, with a different teacher, who had not attended the planning meeting, teaching the lesson. Only the HOD, the two pre-service teachers, and the teacher who taught the lesson attended any of the revision and post-lesson discussions.

School C implemented each lesson study cycle over four days, with lessons being taught during the ninth period of the day, when students usually had prep, so that teachers did not have to leave their classes to attend. Almost all of the mathematics teachers took part in all phases of the two lesson study cycles. In addition, the Deputy Headteacher also attended research lesson 1 and the revision session. While both planning meetings lasted over an hour, the total time taken for the two revision sessions and the post-lesson discussion for lesson 1 was just over half an hour, with the second 3-minute revision session in cycle 2 resulted in the conclusion that no revision was needed and so there was no revised lesson. During the first lesson some observers marked student work, but after being reminded by the Deputy
Headteacher that they should instead be observing the lesson closely, they all remained in their seats.

Overall, a major constraint on the implementation of lesson study was the amount of time involved. Teachers who were involved in teaching APU classes were particularly busy and unavailable for meetings when they had afternoon classes scheduled. Where schools held planning meetings during school hours in the morning, teachers were often late in arriving because they went to their classes first to assign them work. With the pressure of getting students to pass their examinations, many teachers regarded lesson study as a waste of time. Even when teachers attended planning meetings, they often did not attend revision sessions and revised lessons, and sometimes did not attend even the lessons they had planned. School C was the only one to make changes in their scheduling of lesson study in an attempt to solve this problem. However, this was a prestigious boarding school where the students had a prep session in the afternoon which could be utilised for research lessons.

6.5.3 The mathematical focus of the planning team

The evidence from the lesson plans at all three schools suggest that the focus was more on the correctness of the answers to the tasks than eliciting student mathematical thinking. Typically, according to the lesson plans, students were expected to be attentive and listen to the teacher, respond to verbal questions, seek clarification from the teacher when needed, copy notes, perform calculations, and attempt tasks in their notebooks or on the chalkboard. Occasionally students were expected to participate in discussions, particularly about other students’ solutions as demonstrated on the chalkboard. However, these discussions were usually very short and did not probe students’ understandings. The fact that some observers joined the teacher in marking students’ books and helped students complete the tasks, also suggests that the focus of the planning teams was the “correct answers”.

On the few occasions when the lesson plans listed anticipated responses from students to teachers’ questions, they were either quite general – such as “moving fast”, “high speed” – or the only responses suggested were the correct answers to the questions – for example, if $a^x = y$ then students were expected to respond that $x = \log_a y$. The planning teams appeared to want students to use the examples the teacher had completed on the board to attempt the exercises set, sometimes without regard for the different levels of difficulty involved. At no stage did the planning teams anticipate difficulties students might encounter or any misconceptions students might have. The lesson plans also did not state any strategies or prompts that teachers could use to help students who had difficulties in completing the
exercises.

At Schools A and B, there was some confusion about the place of the topics in the new curriculum and the prior knowledge expected. This was particularly confounded by the fact that at School B no consideration was given to the fact that trigonometric functions were a Grade 10 topic on the Additional Mathematics Syllabus and some students, particularly in the afternoon retaught lesson, were taking Additional Mathematics and others were not. There was also a mismatch between the objectives stated for the first lesson at School A and the lesson content, while in the first iteration of the lesson the teacher neither established that students already knew how to produce pie charts (the entire focus of the lesson) nor attempted to show how them how to do this, while the post-lesson discussion of the retaught lesson (where instruction was given) revealed that the teacher (and possibly other members of the planning team) were themselves uncertain as to the correct procedure.

At School C however, while the lesson plans produced might suggest a focus on correct answers, in the actual planning sessions there was frequent robust discussion of potential challenges for both students and the teachers and their solutions. For example, the discussion as to whether or not students would be challenged by the teacher using the same numbers for the two examples to illustrate profit and loss led to the planning team suggesting that the teacher should tell the students that negative numbers denoted a loss. The planning team, having decided that making students appreciate the use of logarithmic functions in solving real-life problems was to be the “value rationale” for a lesson, were themselves then challenged to find real-life situations where exponential and logarithmic functions are used, and proposed (and later used) engineering as an example.

### 6.5.4 The mathematical focus of the teacher during the research lessons

The evidence from the classroom data suggests that the teacher’s mathematical focus during the research lessons at Schools A and B was more on the correctness of the answers to the tasks than on students’ mathematical thinking. For example, in the first iteration of the pie chart lesson at School A, the teacher focussed mainly on the numbers used in the three quite different solutions students presented on the board and did not ask students to explain how they had arrived at their solutions. The fact that some students (including two of the three who had demonstrated their solutions) appeared to have serious misconceptions about pie charts was only raised during the post-lesson discussion after the revised lesson. This was not resolved even then, with the teacher who taught the lesson stating that he did not focus on methods for calculating the angles, as all that mattered was that students should come up with the correct
angles. In the first iteration of the lesson on speed at School B, the task the teacher asked students to complete was conceptually much more difficult than the two tasks which the teacher had demonstrated as it involved both a conversion of distance and a transposition of the formula for average speed. However, at School C it was obvious in all lessons that the teachers involved were not satisfied with students just getting the correct answers. Instead students were expected to give explanations for their answers.

6.5.5 The mathematical focus for students during the research lessons

It is difficult to find evidence about student thinking during the research lesson because post-lesson discussions were often very short, poorly attended, and rarely focussed on students’ thinking (probably due to lack of evidence collected by the observers).

There were, however, instances observed at Schools A and B where students pointed out errors in other students’ solutions or gave answers that surprised their teachers, suggesting that students were looking beyond just getting a correct answer. It also demonstrates the wide range of prior knowledge in the class and emphasises the need for the planning team to have anticipated student solutions when planning the lessons. A notable feature of the second lesson at School C was the fact that the students who were asked to present their solutions before the class were asked to explain their thinking, and regularly included their classmates in their presentations, suggesting that students expected to look beyond the “correct answers”.

6.5.6 Opportunities offered by the lesson studies observed

The lesson study cycles observed at the three case schools offered a number of opportunities for teachers to develop professionally. These included opportunities for teachers to develop their skills and knowledge of the mathematics content of the curriculum, to be exposed to strategies for making their lessons more student centred, and to tease out the meaning of different teaching “methods” such as discussion, problem solving, inquiry and guided discovery.

However, the lack of adequate planning time at School A, the brief time allocated to the revision sessions and the post-lesson discussions at Schools A and B, and the fact that at School B only once did any teacher other than the HOD, the teacher teaching the lesson, and two pre-service teachers attend the research lessons or subsequent discussions meant that many potential opportunities for teacher professional learning were not realised.
Chapter 7 Effect of the implementation of lesson study in mathematics

This chapter addresses the research question SQ4: What has been the effect of the implementation of lesson study in mathematics in Zambia?

Findings in this chapter are based on an analysis of key publications of the Ministry of Education, interview data, observations at schools A, B and C, and results from Grade 12 Mathematics national examinations.

7.1 The Ministry of Education impact assessments

This section presents the effect of lesson study described in the two Zambian Ministry of Education impact assessments of the introduction of lesson study through the School-Based Continuing Professional Development (SBCPD) programme.

7.1.1 Key publications

As discussed in earlier chapters, lesson study was first introduced in science at Grades 8 – 12 in Central Province in 2005 and extended to mathematics and other subjects in 2008 in the Central, Copperbelt and North-western Provinces, as well as to the other provinces, in 2011.

The first four documents listed in Table 7.1 include many references to expected outcomes from the introduction of lesson study in Zambia.

In particular, the introduction of lesson study was expected to: deepen teachers’ knowledge and skills (MOE & JICA, 2010b); improve teachers’ attitudes towards mathematics (MOE & JICA, 2009); and result in a shift from teacher-centred learning to more student-centred learning (MOE & JICA, 2010b). According to the Implementation Guidelines (MOE & JICA, 2010b), teachers are an important factor in bringing about improved student learning. In particular, collaboration among teachers, and improved teachers’ attitudes, knowledge and skills are important elements in fostering improved student learning. As a result, the implementation of lesson study was expected to improve student learning, especially as shown in national examination results (MOE & JICA, 2010a; MESVTEE & JICA, 2015).
Table 7.1 Ministry publications describing the expected and observed effects of lesson study

<table>
<thead>
<tr>
<th>Full title of the document</th>
<th>Hereafter called</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Teaching Skills Book</em></td>
<td></td>
</tr>
<tr>
<td>School-Based Continuing Professional Development (SBCPD) Through Lesson Study: <em>Teaching Skills Book</em> (MOE &amp; JICA, 2009)</td>
<td><em>Teaching Skills Book</em></td>
</tr>
<tr>
<td>Implementation Guidelines</td>
<td>Implementation Guidelines</td>
</tr>
<tr>
<td>Management Skills Book</td>
<td>Management Skills Book</td>
</tr>
<tr>
<td><em>Master Plan</em></td>
<td></td>
</tr>
<tr>
<td>School-Based Continuing Professional Development (SBCPD) Through Lesson Study: <em>Implementation Guidelines</em> (MOE &amp; JICA, 2010b)</td>
<td><em>Master Plan</em></td>
</tr>
<tr>
<td>School-Based Continuing Professional Development (SB CPD) Through Lesson Study: <em>Management Skills Book</em> (MOE &amp; JICA, 2010c)</td>
<td><em>Master Plan</em></td>
</tr>
</tbody>
</table>

The last two publications listed in Table 7.1 deal primarily with the observed effects of the introduction of lesson study. These impact assessments, conducted in 2010 and 2015, are planned to be repeated at five-yearly intervals (MESVTEE & JICA, 2015, p. vi). The methodology and the findings from the first two impact assessments are discussed below.

7.1.2 The first impact assessment

The Ministry, with the help of a short-term expert from the Japan International Cooperation Agency (JICA), conducted the first impact assessment study in 2010 to “understand the impact of the SBCPD programme, especially the impact of lesson study activity at the school level” (MOE & JICA, 2010a, p. 2) in Central Province. The aim of the study was to answer the following three questions:

- Have the SBCPD activities had a positive impact on the results of national examinations in Central Province?
- Have the SBCPD activities had a positive impact on teachers’ attitudes, teaching processes, and student attitudes?

Lesson study was regarded as one of the components of the SPCPD programme.
• What background factors have made an impact on the effects identified? (MOE & JICA, 2010a).

A database of the pass rate for the national examination in Grade 12, collected from the Examinations Council of Zambia (ECZ), was used for a difference-in-difference analysis of data from Central Province and non-target provinces before and after the lesson study intervention conducted through the School-Based Continuing Professional Development (SBCPD) programme.

The assessment team also visited 29 high schools (Grade 10-12) in Central Province as part of a field survey to verify the documentation of lesson study activities, collect questionnaires, and conduct interviews with participants as shown in Table 7.2.

Table 7.2. Numbers and types of participants in the first impact assessment (Source: MOE & JICA, 2010a, p. 5)

<table>
<thead>
<tr>
<th>Participants</th>
<th>Questionnaire</th>
<th>Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>School heads</td>
<td>29</td>
<td>10</td>
</tr>
<tr>
<td>Facilitators [in science]</td>
<td>23</td>
<td>10</td>
</tr>
<tr>
<td>Science teachers</td>
<td>136</td>
<td>15</td>
</tr>
<tr>
<td>[Students] (Grade 12)</td>
<td>280</td>
<td>-</td>
</tr>
</tbody>
</table>

As can be seen in Table 7.2, mathematics teachers did not participate in the assessment. Lesson study in mathematics was not part of SMASTE-SBCPD Project phase I, which covered only science. Mathematics was only introduced during SMASTE-SBCPD Project phase II, which started in 2008 and covered all subjects in Central Province. However, the “pass rate for mathematics, which may be affected by the intervention of the SBCPD programme [SMASTE-SBCPD Project phase II] started in 2008, was also analysed as a comparison subject” (MOE & JICA, 2010a, p. 7).

Impact on national examination results

Science and biology

Before the beginning of SMASTE-SBCPD Project phase I in 2006, the pass rates for science and biology in Central Province were slightly lower than those in the non-target provinces. However, by 2009 the pass rates for science and biology in Central Province exceeded those in the non-target provinces by 12.4% and 19.2%, respectively, with both of

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4 In Zambia, ‘science’ is a combination of chemistry and physics. Hence, mathematics and biology are not regarded as part of science.
these differences being statistically significant at the $p < 0.01$ level (see Figure 7.1 and Figure 7.2).

Figure 7.1. Pass rate for science (Source: MOE & JICA, 2010a, p. 6)

Figure 7.2. Pass rate for biology (Source: MOE & JICA, 2010a, p. 6)

While these results show a remarkable improvement in the results in both science and
biology for Central Province, the *Impact Assessment Report of 2010* notes that the pass rate for science started much lower than for other subjects and therefore provided more opportunity for improvement. In addition, the “intense input focused on the capacity development of facilitators and teachers in science appeared to contribute to the increase in pass rate” (MOE & JICA, 2010a, p. 9).

In an effort to assess whether or not lesson study was a major contributing factor in the improvement of examination results in science and biology, a scale to measure the level of implementation of SPCPD was constructed, based on a document analysis of three aspects of the implementation of SPCPD at the 29 schools participating in the study: lesson observation instruments; lesson plans; and the SPCPD action plan. Each of these was given a rating from 0 (indicating that it was not in evidence) to 4 (indicating involvement of the head, deputy head, or head of department, or in the case of the SPCPD action plan, it being revised according to progress). The ratings for each aspect were added together to give an overall score for “level of implementation”. Based on this “scale”, a positive correlation of 0.70 was quoted between the level of implementation of SPCPD and the pass rate, statistically significant at the $p < 0.01$ level. However, as the data were ratings, the use of a parametric correlation coefficient is invalid. The text of the report does not set out the statistic that was used to calculate the “correlation”.

Additionally, these results need to be treated with some caution as one Headteacher was quoted in the report as stating that “when [district officers] come … they just check, but do not going deep into it … It is very easy to produce such records, even when we did not conduct”, while a teacher said, “Most lesson plans are written in order to keep the file up-to-date, not really to prepare for lessons in the classroom” (MOE & JICA, 2010a, p. 16).

### Mathematics

While mathematics was only introduced into *SMASTE-SBCPD Project phase II* in Central Province in 2008, the *Impact Assessment Report of 2010* also compared the pass rate in mathematics between Central Province and the non-target provinces.

As can be seen in Figure 7.3, no statistically significant difference was found, leading the authors to the unwarranted conclusion that “This indicates that tangible impact on the pupils’ achievement became evident after a certain period of the SBCPD programme intervention at the school level” (MOE & JICA, 2010a, p. 7).
Impact on teachers and teaching

While the interview questions for all three categories of participants (Headteachers, Facilitators, and Science teachers) included questions such as “Do you think SBCPD activities are effective in improving science teacher’s ability?” and “Have you observed any change in attitude or practice in lesson of the teacher who participated in SBCPD activities?”, the report does not address responses to these questions directly.

However, one facilitator was quoted as saying that sharing activities and looking at different topics together had helped build teachers’ confidence. In another quote from a facilitator, it was stated that teachers’ interactions and the sharing of knowledge has improved student achievement as friends “can teach the topic on behalf of you or you can learn about it from them. We are thus now able to tackle even difficult topics. We do not avoid them. So, pupils cover most of the topics. As a result, the pass rate for exams improves” (MOE & JICA, 2010a, p. 10). It is somewhat disturbing to see that it is regarded as good practice for teachers to teach difficult topics to other teachers’ classes and that without these new practices it was not possible to “cover most of the topics”.

Regarding a possible shift from teacher-centred learning to more student-centred learning, the report used student responses to the following two questions on the student questionnaire: “Teacher provides pupils with observation and experiments in science class”
and “Teacher organizes small group discussion session in science class” as a measure of student-centred learning. Each question uses a 5-point Likert scale ranging from Never to Always, with the scores being added to give the level of student-centredness. Based on this “measure”, the study found a positive correlation between the level of SPCPD implementation and student-centred lessons, with $r = 0.33, p < 0.05$. However, the method adopted to calculate this “correlation” is not mentioned in the report. A sole clue is the quote of “$r$” which, if it is Pearson’s “$r$”, is invalid for ratings. This means that the claimed results need to be assessed carefully.

SPCPD activities were seen by interviewees as promoting student-centred lessons, with advantages for students ranging from being better prepared for practical examinations due to experience with hands-on activities to the participation of girls improving due to participating in discussions with their peers (MOE & JICA, 2010a, p. 15). However, “many stakeholders suggested that one of the main challenges in conducting learner-centred lessons in their [science] classrooms was the lack of materials” (p. 16).

**Factors relating to SPCPD implementation**

Further analyses were conducted and all are to be treated cautiously as no details are provided.

An analysis using correlations between the level of SPCPD implementation, student pass rates, and various variables identified through the questionnaires found a positive correlation between grant-aided schools and the pass rate ($r = 0.47, p <0.05$) and the level of SPCPD implementation ($r = 0.58, p <0.01$). Again, as there are no details, these results must be treated with caution. The report noted that grant-aided schools have advantages such as “smaller workload for teachers, lower pupil-teacher ratios, and sufficient budgets and science facilities supported by their church missions [with] most grant-aided schools [having] also established accurate internal monitoring systems to keep track of the quality of SBCPD activities” (MOE & JICA, 2010a, p. 13).

Grant-aided schools also showed a strong negative correlation ($r = – 0.65, p <0.01$) with conducting APU classes. Schools with APU classes were strongly positively correlated with high student-teacher ratios ($r = 0.57, p <0.01$) while grant-aided schools were negatively correlated with high student-teacher ratios ($r = – 0.44, p <0.05$). Teachers’ workload was also strongly negatively correlated with the level of SPCPD implementation ($r = – 0.60, p <0.01$). The only other statistically significant correlations found were between the allocation of trained facilitators and pass rates ($r = 0.44, p <0.05$) and the level of SPCPD implementation ($r = 0.38,$
Further, these results require care in their interpretation as correlation does not necessarily mean causation. As Gravetter and Wallnau (1992, p. 477) put it, “a correlation should not and cannot be interpreted as a proof of a cause-effect relation between two variables”.

### 7.1.3 The second impact assessment

The Ministry conducted the second impact assessment in approximately half of the districts in each of the Central, North-western and Eastern provinces. The Ministry justified the selection of these three provinces as follows:

The Central Province was chosen in order to compare with the previous survey results obtained in 2010. North-western was selected as an experienced Province, and like Central Province, transiting from the SMASTE to the STEPS Project, while Eastern was relatively a new Province specifically under the Project. (MESVTEE & JICA, 2015, p. 9)

The overall question that the second impact assessment sought to answer was: What impact did lesson study have on the teaching/learning experiences in Zambian schools? The three subsidiary questions were the same as for the first assessment.

Grade 12 examination results for the period 2009 to 2013 were collected from the Examinations Council of Zambia and analysed for a trend in the Grade 12 students’ pass rates.

Table 7.3 *Participants in the Impact Assessment of 2015 by province* (Source: MESVTEE & JICA, 2015, p. 10)

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>EASTERN</th>
<th>CENTRAL</th>
<th>NORTHWESTERN</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Interviews</td>
<td>Questionnaires</td>
<td>Interviews</td>
<td>Questionnaires</td>
</tr>
<tr>
<td>EO-TE</td>
<td>x</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>PRCC</td>
<td>x</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>DESO</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>DRCC</td>
<td>3</td>
<td>6</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Head teacher</td>
<td>4</td>
<td>18</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>Facilitator</td>
<td>4</td>
<td>15</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>Teacher</td>
<td>4</td>
<td>59</td>
<td>5</td>
<td>72</td>
</tr>
<tr>
<td>Student</td>
<td>360</td>
<td>420</td>
<td>300</td>
<td>1080</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>453</td>
<td>30</td>
<td>634</td>
</tr>
</tbody>
</table>

Key:
Semi-structured interviews were carried out with a range of participants in the study, as shown in Table 7.3. Questionnaires were adapted from those used in the first impact assessment to include mathematics, with approximately half of the teachers completing the questionnaire being teachers of mathematics. As can be seen in Table 7.3, students responded to the questionnaires but were not interviewed.

**Impact on national examination results**

The trend analysis of the national examination results shows fluctuation in the pass rates for both science and mathematics over the period. As can be seen in Table 7.4, the pass mark in both science and mathematics rose between 2009 and 2010, after which it fell in 2011 and then rose in 2012 and 2013, with the fluctuations being more marked in science than in mathematics.

![Figure 7.4. Trend Analysis of the National Examination Results from 2009 to 2013](Source: MESVTEE & JICA, 2015, p. 17)

According to the *Impact Assessment Report of 2015*, “a similar fluctuation is observed in each of the three provinces involved in the survey” (MESVTEE & JICA, 2015, p. 17). However, it is interesting to note that Table 7.5 does not show the same dip in the pass rate in 2011 as for the national figures – in fact, apart from a slight dip for science in Central Province, all the figures indicate a rise in the pass rate for 2011. The report goes on to state that “It is noteworthy to mention that
Northwestern and Central recorded significant improvement in both Science and Mathematics while Eastern province made a marginal improvement” (pp. 17-18).

However, unlike in the Impact Assessment Report of 2010, where a difference-in-difference analysis was used, with levels of statistical significance stated, there was no suggestion as to what was meant by a “significant improvement”. There was also no attempt to investigate why the three selected provinces showed such differences in trends in their examination pass rates.

![Trend Analysis of the National Examination Results (by province) from 2009 to 2013](Source: MESVTEE & JICA, 2015, p. 17)

As was the case in the first impact assessment, a scale to measure the overall level of implementation of SPCPD was constructed. This time, however, the scale was based on responses to a large number of items on the questionnaires completed by the headteachers, facilitators and teachers (see MESVTEE & JICA, 2015, p. 20). Typically questions used a five point Likert-type scale and included questions such as “How often does your school conduct the SBCPD activities per term?” and “How many times did you participate in facilitator workshops per year?” Scores were totalled, with a maximum score of 317 available for this part of the questionnaire. Based on this self-reporting, a positive correlation of 0.29 was found between the level of implementation of SPCPD and the pass rate across all science and mathematics subjects, with \( p < 0.05 \) (p. viii) and a positive correlation of 0.49 between the level of implementation of SPCPD and the pass rate in mathematics with \( p < 0.01 \) (p. 22).

In the same vein, the report noted that stakeholders were of the view that lesson study would help improve student achievement, stating:

It was emergent from the views expressed by most of the stakeholders that the interventions put in place by the STEPS Project, working [with] MESVTEE were
bearing fruit and that lesson study was effective in improving [students’] achievement including pass rate of the national examination. (MESVTEE & JICA, 2015, p. viii)

While the report claims that Figures 7a and 7b “show that the more Lesson Study activities in a school, the higher the learner achievement in examinations” and that “This can be attributed to the amount of efforts by teachers aimed at improving ways of delivering lessons (through Lesson Study)” (p. 21), it needs to be noted that the level of implementation is based on self-reporting. Moreover, these results only show a correlation between levels of implementation and pass rates, with 23% of teachers who responded to the questionnaire stating that they could not tell whether or not lesson study had any impact on learner achievement or whether there were other contributing factors (p. 19).

Furthermore, the figures in the report do not always match the conclusions stated or explain their meaning adequately. For example, in Figures 7a and 7b (p. 21) it is not at all clear what the difference is between the labels on the two x-axes: Level of implementation (Overall) in Figure 7a and Lesson study implementation in Figure 7b, or even what Figure 7b is meant to represent. Also, the text relating to Figures 8a and 8b claims that the positive relationship between lesson study implementation and learner achievement “was even more evident when learner performance in each subject was correlated and regressed with the Lesson Study implementation” (p. 21). However, these figures are based on self-reporting on a different set of questions classified as Level of implementation (Teaching skills) in each of mathematics and science.

**Impact on teachers and teaching**

Unlike the case of the Impact Assessment Report of 2010, the Impact Assessment Report of 2015 did not include a copy of the interview schedule, but only the questionnaires, and there is very little evidence provided to support the conclusions reached regarding the impact of lesson study on teachers and teaching.

For example, while the Executive Summary section stated that 94% of teachers claimed that “during lesson study, at the planning stage, they were able to think deeply about long-term goals by carefully considering the connection of daily instruction of a particular content area, unit and lesson of a topic to long-term goals” (MESVTEE & JICA, 2015, p. viii), there is no evidence of this provided anywhere in the report.

The Executive Summary also stated that
91% of teachers who have been involved in Lesson Study activities are able to testify that the Programme has indeed continued to change their attitudes in terms of the way they perceived some topics in their respective subject areas, how such methods can enhance learner performance in national examinations, and how they used to perceive learners as empty vessels. (MESVTEE & JICA, 2015, p. viii)

However, again this is not backed up elsewhere in the report.

Nevertheless, the report states that “Lesson Study has positively impacted [sic] on the teachers’ attitudes towards their engagement in Lesson Study activities as well as towards their understanding of the pedagogical content knowledge and teaching processes”, with 46 out of 53 Headteachers claiming that “they had observed a marked improvement in lesson delivery” (p. 23) and “86.9% teachers [stating] that Lesson Study activities were useful for improving teachers’ teaching” (p. 25).

According to the Executive Summary, teachers had also realised that lesson study “can only be driven by the teachers themselves and, therefore, they have developed motivation and willingness to improve” (p. viii).

According to the Ministry, students’ perception of mathematics as a difficult subject could have made them develop a negative attitude towards learning mathematics (MOE & JICA, 2010a; MESVTEE & JICA, 2015). While the Impact Assessment Report of 2010 does not discuss student attitudes, the Executive Summary of the Impact Assessment Report of 2015 reported that:

[Students’] attitudes towards learning mathematics have also significantly improved. About 64% of the learners appreciated the learning strategies that their teachers have been employing during lessons and how their perception of Science and Mathematics as difficult subjects have since changed. (MESVTEE & JICA, 2015, p. ix)

Based on the results of the questionnaire, 94% of students were reported as being encouraged to express their opinions freely and explain how they had arrived at their solutions, (MESVTEE & JICA, 2015, p. 22).

Regarding a possible shift from teacher-centred learning to more student-centred learning, the report uses student responses to ten questions on the student survey together with an additional total of three questions from the facilitators’ and teachers’ surveys to construct a scale for learner-centredness, finding a “correlation (r = .31*, p < 0.05) between overall level of implementation of the lesson study and the delivery of learner-centred lessons (p. 24)!
The section reporting on the impact of lesson study on teachers and teaching concludes with the statement “In Lesson Study, teachers tend to focus on problem-solving in order to provide leaners with opportunities to build their knowledge of content through solving problems but also to improve their skills in attempting unfamiliar questions” (p. 25). However, there is no supporting evidence provided nor any discussion of this important aspect.

**Factors relating to the implementation of lesson study**

An analysis using correlations between the self-reported level of implementation of lesson study, student pass rates, and various variables identified through the questionnaires again found a positive correlation between grant-aided schools and the pass rate ($r = 0.50$, $p < 0.01$), but, unlike the 2010 report, no significant correlation with the level of lesson study implementation was found. Grant-aided schools again showed a strong negative correlation with high student-teacher ratios ($r = -0.44$, $p < 0.05$). Teachers’ workload was also strongly negatively correlated with the level of SPCPD implementation ($r = -0.38$, $p < 0.01$). No other statistically significant correlations were found and unlike in the 2010 report, no significant correlation was found between the allocation of trained facilitators and any other variables. Again, there is little evidence to support these claims as valid.

**7.1.4 Summary**

The *Impact Assessment Reports of 2010 and 2015* contain many positive findings related to the implementation of lesson study through the School-Based Continuing Professional Development (SBCPD) programme.

However, the *Impact Assessment Report of 2010* related almost exclusively to the teaching of science in Central Province, as lesson study was only implemented in mathematics in 2008. When comparing the pass rate in mathematics between Central Province and the non-target provinces no statistically significant differences were found.

The Ministry conducted the second impact assessment in the Central, North-western and Eastern provinces, including both science and mathematics. According to the *Impact Assessment Report of 2015*, North-western and Central provinces recorded significant improvement in both Science and Mathematics, while Eastern province made a marginal improvement”. However, it is not clear what was meant by a “significant improvement” and there was no attempt to investigate why there were such differences in trends in their examination pass rates in the three provinces, while many teachers “felt that there could be other contributing factors other than Lesson Study” (MESVTEE & JICA, 2015, p. 19). Based
on a correlational analysis between self-reported levels of implementation of lesson study, student pass rates, and various variables, statistically significant correlations were found between being a grant-aided school and pass rates and low student-teacher ratios, with teachers’ workloads was also strongly negatively correlated with the level of lesson study implementation. Analysis of the teacher and student questionnaires, also found a high proportion of respondents to have reported improved attitudes towards mathematics.

7.2 In-service providers’ views on the effects of lesson study

The two Ministry of Education Officers (MOE1 and MOE2) and the six other in-service providers (ISP1 – ISP6) who were interviewed were asked to describe the effects of lesson study. There was a consensus in their reporting that lesson study had a positive effect on teachers and teaching, as well as on students’ attitudes and learning.

7.2.1 Effect of lesson study on teachers and teaching

MOE1 stated that teachers, particularly in mathematics and science, had been reporting that they no longer felt isolated or afraid to teach difficult topics because of their involvement in lesson study:

If you meet challenges and you are not able to solve it as a teacher, teaching mathematics can be a lonely activity. But because there’s that forum where they [teachers] meet, present their situations to colleagues and they solve them together as a group, many teachers are saying they are no longer feeling lonely or afraid of addressing certain topics with the learners because they're now able to know that there's support among their colleagues. (MOE1)

According to ISP3, lesson study helped to improve collaboration among teachers thereby improving their performance. ISP3 said that in the past it was quite difficult for a teacher to ask a colleague to help teach a specific topic the teacher was not comfortable with, and lesson study had helped solve the problem:

However, for now, those things do not happen. You reach a level where you realize your potential and appreciate what your colleague holds. X, you are best when teaching the linear programming. Kindly when you are done in your class can you teach mine linear programming? I will be able to teach vectors in your class. (ISP3)

Further, MOE1 said that teachers who had problems with difficult parts of
Many mathematics teachers had problems on certain topics before lesson study was introduced in schools. Because of lesson study, teachers discussed the problems they had with their colleagues and were able to gain a deep understanding of the certain topics. They opened up, called their friends to say, “This area, what am I supposed to do?” Their shyness was gone because now they were working together. (MOE1)

According to ISP5, lesson study had helped teachers to become more open to criticism and appreciate different ways of presenting their lessons:

Lesson study has helped teachers be more open to criticism, that is critiquing the teaching and preparations. They have seen that mathematics does not have to have one fast way of being presented. When they come together, they see the different ways of presenting the idea, the same concept to students. (ISP5)

ISP5 claimed that lesson study was helping to transform the traditional teacher-centred lesson to student-centred lessons, stating that teachers had started seeing a better way of presenting mathematics and not the traditional way where the teacher stood before the class and solved the mathematics problem. ISP5 stated “We have seen many students’ involvement. So we have moved away from teacher-centeredness, and we are nicely moving toward learner-centredness methodologies of, or approaches to, teaching mathematics” (ISP5). According to ISP2 and ISP6, observing lessons had helped to motivate teachers to improve teaching, with ISP6 stating, “Teachers have developed professional ability such that some teachers that come from colleges will have improved because of planning together, coming together, observing lessons, and eclectic involvement of methods”.

7.2.2 Effect of lesson study on students and learning

MOE1 stated that the study conducted by the Ministry that formed the basis for the Impact Assessment Report of 2015 evaluated the lesson study project to establish its effect on student learning, teaching, teacher skills, the passing of the examinations. He stated that

We had experts who came from JICA. They conducted a survey by going to Examinations Council of Zambia, collecting all the results over a period of about four years in science, mathematics. … When they analysed them, they found that … the graph for Central Province started rising above that for non-participating provinces in science, mathematics. It was a significant difference in terms of performance between the children. So, what we concluded ourselves is that probably
it is lesson study that could be having an effect on the performance of children because of the quality of teaching … had improved in that province, and the children themselves were saying they were enjoying science and mathematics more because of the different ways in which they were being taught. (MOE1)

Furthermore, MOE1 stated that the results from the Impact Assessment Report of 2015 showed that students in Zambian schools had started enjoying mathematics and science lessons because of lesson study and that teachers had started involving students in their lessons more. Further, he stated that:

Just last week, we finished analysing the results of that evaluation. Children are saying they are enjoying science and maths because of lesson study. … The children are saying they have seen a remarkable improvement in ways teachers present lessons to them. They are involving them more in activities. Therefore, there's been an impact. (MOE1)

MOE2, however, was sceptical that the three provinces (Central, Copperbelt and Northwestern) that implemented lesson study first in Zambia were still enthusiastic about lesson study. He said that he had attended a meeting in January 2015 where they analysed the lesson study reports from these three provinces, and they concluded that they were not performing better than they did when they first implemented lesson study:

Then we have seen a situation where I think they have relaxed. After it [lesson study] went everywhere in the provinces, they seem to have relaxed. Maybe [it is due to] fatigue. Some of the provinces that started lesson study later are doing much better than them [Central, Copperbelt and North-western]. That is another challenge probably, which we have to find a way of … re-invigorating the old provinces and making the new provinces continue with the same enthusiasm in the practice of lesson study. (MOE2)

7.2.3 Summary

Overall, there were few differences between the effects of lesson study described in the Ministry documents and those described by the in-service providers, with these interview participants describing some of the same effects as those stated in the Impact Assessment Report of 2010 and the Impact Assessment Report of 2015.

However, MOE2 raised the issue of lesson study sustainability in provinces where lesson study was first implemented. This view seems to be supported by the six lesson study
cycles observed at School A, B, and C. Among the three schools, B performed the least well in terms of adherence to the requirements set by the Ministry and yet it was among the first schools where lesson study was implemented in Zambia, with lesson study commencing in science in 2005 and in mathematics in 2008. Lesson study at Schools A and C was introduced in 2012 and 2014, respectively. School C was a new school, whose construction was completed late 2013. The teachers at both schools were more committed to lesson study than those at School B. For example, all the teachers who planned Lesson 1 and 2 at School A observed the lessons, attended the reflection sessions, observed the re-teaching of the revised lessons, and attended the post lesson discussions. In the case of School B, the teachers who planned Lesson 1 did not observe the lesson, and the lesson was re-taught by a different teacher, who later chaired the post lesson discussion, which was only attended by two pre-service teachers and the Head of Department.

7.3 School administrators’ views on the effects of lesson study

The five school administrators (the Head Teachers HTA, HTC, HTC, and the CPD co-ordinators CA and CC) who were interviewed were also asked to describe the effects of lesson study. A summary of their views is given below.

7.3.1 Effect of lesson study on teachers and teaching

There was a consensus among the school administrators that lesson study had brought about more collaboration among teachers, and between teachers and school administrators. CA stated: “We have seen some teachers actually collaborating in planning and now they are even using the lesson plans. They have come to demand the lesson plans if they are on the topic that was covered using lesson study”. Similarly, HTC said “I think it helps in bringing my teachers and me closer because now we are interacting at a different level other than the one we normally have”.

Apart from lesson study enhancing collaboration among teachers, it was also seen as helping teachers to teach mathematics more effectively. Some administrators mentioned that teachers had become more competent in introducing the lesson, developing the lesson, and handling the learner activities. CC, for example, stated; “You can really tell that it is due to our activities on CPD that have made teachers be so effective in handling classes”.

Similarly, HTA said that lesson study had improved the confidence of teachers to present the lesson:
In every school, you have those teachers that are a bit timid, a bit lazy. They feel inadequate. Therefore, we identify such teachers. Moreover, because of the lesson study, I have seen that such ones are no longer there. Not even the HOD coming to complain to me that this teacher is failing to deliver. I think lesson study has helped some teachers to walk into a classroom and teach without being intimidated. (HTA)

The view by HTA that lesson study boosted teacher confidence was echoed by CC:

We have had some teachers that have problems or maybe not feeling very free when being observed by their colleagues. Because CPDs actually encourage peer observation, those teachers have come out of such problems. This time they can deliver and deliver effectively even when a colleague sat behind there [at the back of the classroom]. Therefore, the performance of the teachers has actually greatly improved for those that have taken this programme quite seriously. (CC)

What improved teacher confidence, according to HTC, were the skills teachers acquired while participating in lesson study and the opportunity to seek help from colleagues on difficult mathematics topics. HTC stated that “Lesson study had a significant effect on teachers. Some teachers have understood the essence of lesson study. Some teachers have mentioned that topics they have problems with, they asked for help from their colleagues during lesson study sessions”. Furthermore, HTC was of the opinion that lesson study had been a useful tool for converting low performing teachers into high performers, stating that lesson study had also helped the pre-service teachers from the University to learn methodology practically.

### 7.3.2 Effect of lesson study on students and learning

Three of the five school administrators commented on the effect lesson study had on students. They were confident that lesson study had brought about improvements in students’ test results and students’ understanding of mathematics concepts. HTA reported that his school had analysed students’ results in mathematics for mid-term and end-of-term tests, and found a small improvement. Such small improvements in students’ performance did not surprise the Head Teacher at school B, HTB, because lesson study was a relatively new CPD approach in schools.

The Headteacher at School C said lesson study had helped his school meet the pass rate target the school had set:
We have set our passing rate to 70%. If a child gets less than 70, they have failed in this school. So, when they do a lesson study and teachers go back to teach, children improve in those [difficult] topics and we have seen the assessments improving. We see children improving and children have been singled out to say this one was a bad child in this area but look at where she is now. (HTC)

Further, HTC was confident that, from the time the school introduced lesson study, student results in mathematics had been increasing. He said “We even produced a child who had 100% in mathematics. We had to get children who produced results between 100% and 90% in mathematics, and these children were children from just ordinary schools”.

According to CA, lesson study had helped students understand mathematics concepts better and develop a greater interest in classroom activities. He said “There is even great understanding coming from students. I observed one lesson study. I saw that the children were so much interested in what was going on”. However, CA was sceptical about the assertion that students were doing better in mathematics because of lesson study; in his opinion, the claim was unfounded because school administrators did not have a tool for measuring the effects of lesson study on student performance:

Those are areas I think people should take interest in, do a bit more research, and then come up with a tool. I have not come up with a tool. I think maybe it’s because of time. You find that you are very busy here and there. I have not just been a CPD Co-ordinator. I am also organizing JETS, [Junior Engineers, Technicians and Scientists] at the regional level. So, you find that we are very busy. (CA)

**7.3.3 Summary**

Overall, there were few differences between the effects of lesson study described by the school administrators and those described by the in-service providers.

The school administrators claimed that collaboration among teachers had improved, displacing the old culture of teaching being seen an individual activity, with teachers now viewing teaching as a collaborative enterprise. The school administrators also focused on how lesson study had increased teachers’ confidence in teaching and being observed by their colleagues.

While some administrators were confident that lesson study had brought about improvements in students’ test results and students’ understanding of mathematics concepts, the CPD co-ordinator at School A was sceptical that students were doing better in mathematics because of lesson study stating that school administrators lacked effective tools to measure the
effect of lesson study on pass rates.

7.4 Teachers of mathematics’ views on the effects of lesson study

The six teachers who taught the six observed research lessons (TA1, TA2, TB1, TB2, TC1 and TC2) were also asked to describe the effect of lesson study as part of the interviews. Their responses are summarised below.

7.4.1 Effect of lesson study on teachers and teaching

Teachers from each of the three schools described positive changes in the relationships between school administrators and teachers, as well as support for carrying out lesson study. For example, TB1 said that because of lesson study there was an increased closeness between school administrators and teachers and increased resource support for teacher activities:

It has had a positive effect, especially that the administrators [who] are encouraging us to do that [lesson study] are ready to actually support [it]. Even when you have lesson study, they will tell you if you need material make a budget. Even at the beginning of the term, we are actually encouraged to make a budget or program towards that. So, in terms of the relationship with the administrators, I will say it has made us get closer than before. (TB1)

A teacher at School A commented that school administrators persistently encouraged teachers to participate in lesson study:

Most of the time you find that those in leadership encourage lesson study. Sometimes teachers might feel relaxed. You know what it is like. But the encouragement is always there that we should be able to do it because that is the best option so far. (TA1)

A teacher from School C reported that school administrators had been ensuring that lesson study activities were timetabled and that teachers acquired the necessary skills for participating in lesson study:

They [school administrators] write the program [timetabling lesson study activities]. They are happy with the programme. They advise teachers in terms of teaching. They [school administrators] are emphasising ... lesson study. They have done a lot to iron out teachers in term of workshops on the same CPD that enable teachers to
acquire a lot of knowledge from their friends and they implement it in a classroom situation. (TC1)

Teacher TA2 noticed that school administrators followed up on teacher activities, especially lesson study:

Like for this school, it is a policy that each term you do two of them [lesson study cycles]. So, you need to account for that. The Head Teacher, for example, will ask how many [cycles] did you do this term. If you did not do, then he would say, “What happened? Why other departments were doing it?” (TA2)

There was also consensus across the teachers that lesson study had promoted staff collaboration. Teachers described staff collaboration using phrases such as “ask from each other”, “interaction among the teachers”, “learns to consult a friend”, “develop trust” and “forum for exchanging ideas”. Some teachers reported that lesson study had bought freedom for them to freely ask each other, and consult. The following examples illustrate the freedom lesson study created for teachers:

We are able to ask each other and discuss. Like last week, we were able to solve certain [mathematics] problems together. So there is interaction among the teachers. We develop trust and ask colleagues stand in for you. There is always rapport and interaction among the teachers. (TA1)

We are very free [with one another]. Because if you are not free to the people that are around you, whom are you going to be free with? So it [lesson study] unites people anyway. It is a way of uniting each other. (TB2)

In the example below, TC1 pointed out that the positive changes in collaboration came about because the teachers were happy with lesson study and were working as a team:

I can say changes are there, positive changes because teachers are happy with the programme [lesson study]. So, the collaboration is now at that high level where everyone learns to consult a friend. Unlike a long time, ago where we … cannot even consult. A friend would say, “after all, I don’t even teach that class if the students fail it is his or her own problem”. However, this time teachers are working together. (TC1)

At the same school, the other teacher compared the way teachers used to work before and after lesson study was introduced:
In fact, it [lesson study] has helped very much, because initially fellow teachers who are mathematicians did not consult or interact with colleagues. Sometimes they will not want to know who you are. It takes time to know each other. But when you have these CPDs, it’s a forum for exchanging ideas. As you are discussing, teachers realise that there were colleagues with a lot of ideas on a topic. So, even when they want to teach that topic they will be free to come to you to consult. So, it [lesson study] is a faster way of making teachers exchange ideas unlike if there was no such CPD forum. It would be difficult. (TC2)

Even when lesson study meetings were over, teachers continued to consult each other. For example, a teacher at School C said,

After the CPDs [meetings] when you go out, they [teachers] will still ask you, “When you were saying this, what did you mean?” Then you explain further. So, we see CPD being a springboard for further communication and discussion. (TC2)

According to the teachers interviewed, lesson study had also helped to strengthen staff relationships, with teachers using phrases such as “developed positive relationship”, “talk to each other freely”, “there is that rapport”, “embraced the spirit of working together”, “shared information”, and “talking to each other”, with TA1 stating:

In the sense that you are able to talk to each other freely knowing that it is a colleague and that you are not looking at one being higher than the other is, because there is that rapport knowing that you are colleagues. We are there, for one thing, to give out to the students and that is in terms of mathematics. (TA1)

The teamwork and information sharing supported by lesson study was considered important for strengthening staff relationships:

Teachers in the Mathematics Department had embraced the spirit of working as a team. Unlike in the past when teachers were competitive and when some teachers considered themselves better than they considered others. Such teachers would keep the information or content to themselves. However, through lesson study cycle we know this one is good at this. Then we share that information. (TB2)

Similarly, TC2 said that lesson study had resulted in teachers being able to freely discuss their problems. He said “There’s that closeness that we develop”. These views expressed by TC2 were echoed by TC1, “We are talking to each other”. While other teachers reported that lesson study had helped to improve staff relationships, a teacher from School A
acknowledged this but cautioned that there was still some resistance among teachers. According to TA2, some teachers had not yet accepted lesson study.

The teachers were asked to describe how their attitudes and views about mathematics had changed as result of their participation in lesson study.

TB1 reported that initially some teachers made statements in class such as, “Mathematics is for real men”, and “Mathematics is for mental geniuses”. According to TB1, making such negative comments would scare off some students, while some would develop a negative attitude towards mathematics. He explained the effect of lesson study as follows:

But through lesson study cycle that barrier is no longer there because the difficult parts of any [mathematics] topic are clarified when planning the demo [research] lesson. Therefore, teachers are able to understand and in turn explain to students in a proper way for them to understand. So, lesson study has contributed somehow to enable students as well as teachers not to perceive mathematics to be very difficult or to perceive mathematics to be just a subject for boys like what it used to be in the past. (TB1)

TA1 said that his perception of mathematics had changed regarding encouraging students to do mathematics. He viewed lesson study as a positive approach for encouraging students to learn mathematics and tackle the questions they came across. He stated that allowing students to present their solutions before the class encouraged other students:

As a teacher, you come in to clarify the students’ presentation and to answer the questions the class has failed to answer. So, with that teacher-pupil interaction, I think lesson study has created a positive attitude in students and teachers. They are able to tackle mathematics, not as the community does perceive it as hard. (TA1)

Similarly, TC1 reported that his and other teachers’ perception that mathematics was a hard subject to teach had changed because of their participation in lesson study:

Traditionally, mathematics was said to be a difficult subject. However, due to the coming of lesson study, I think now mathematics has become simple. Teachers who are facing problems are free to consult each other to come up with the solutions and the right content. The subject is now becoming simpler to teach. (TC1)

According to TA2, the mathematics topics that teachers considered difficult in the past had become simple because lesson study accorded teachers a chance to work as a team:
Teachers cannot teach almost everything. There [are] certain topics that you will have difficulties with. Now those topics, that’s where we bring in lesson study. You say okay on this topic we have difficulties. Let us sit down, plan together how we handle this [topic]. Then wherever you are stuck, you ask your friends. So, there is that collaboration. You are planning together. Others who may know better are teaching others. Then once you are okay with it, you go and teach students. (TA2)

TB2 stated further that when lesson study was introduced at School B, teachers resisted it, but “with the passage of time and conducting lesson study more often, you can produce good results”. However, unlike the other teachers, TC2 reported that his views had not changed much because of lesson study:

My views about mathematics have changed, but not yet very much. Otherwise, what has changed is maybe the way I should approach certain topics when I am teaching. That is what has changed otherwise the view about mathematics there is not much change. (TC2)

7.4.2 Effect of lesson study on students and learning

Teaching mathematics through problem solving is an approach widely used in Japan, particularly in lesson study research lessons (Shimizu, 2003). The Teaching Skills Book, which was written with a main focus on science not mathematics, lists four teaching approaches (Mastery Learning, Inquiry-Discovery, ASEI/PDSI – which focusses on practical hands and minds-on activities, particularly in science – and Problem Solving) and advises teachers to use a mixture of these depending on the context, student characteristics, and the availability of materials (MOE & JICA, 2009, p. 15). Nevertheless, one of the five essential characteristics listed for the lesson development is that it “supports problem solving climate of learning” (p. 15).

Similarly, the Implementation Guidelines states that lesson study promotes “a variety of teaching strategies with a focus on stimulating learning through inquiry, guided-discovery, problem-solving, application, and similar activity-based teaching and learning” (MOE & JICA, 2010b, p. 7). It further states that “The role of the teacher is to help the learner to learn and, therefore, he or she should create situations where learners investigate what is to be learned as a problem to solve by posing and answering questions, discussing and sharing insights, trying out ideas, using concrete models and so on” (p. 13).

There was a consensus among the teachers interviewed at the three case schools that using a problem-solving approach was a challenge, with teachers stating various reasons.
According to TA1, many teachers were not skilled in introducing the tasks to students:

Sometimes when the problems are not introduced well, the students would not be able to answer…. If the presentation [of the task] was not excellent … you find that the students will not be able to answer. In addition, sometimes you find that the problem might include certain things which the teacher did not touch [explain]. Therefore … when the question is given, the students will not be able to answer well. (TA1)

Three teachers (TA2, TC1, and TC2) were sceptical that a problem-solving approach would be effective when teaching mathematics to a class with many low-achieving students, with TA2 stating that:

Problem-solving approach becomes difficult when you have a class that is lowly gifted. Problem solving is good when you have a class that is gifted, where everybody is sharp in class. ... However, for the other class [it] cannot work. You just have to use other methods like teacher exposition. (TA2)

Although TC1 appreciated that problem-solving approach enabled learners to persevere in finding solutions to the task on their own, he believed that approach benefited fast learners mainly.

However, a challenge is that … slow learners … will have no one to ask. ... In addition, if you give them a problem – maybe an assignment to work as homework – they will just keep it since they do not know. Therefore, it is very difficult for that approach to work for slow learners. (TC1)

Similarly, TC2 said that a problem-solving approach was not appropriate for slow learners because if they had difficulties in solving a problem, they would eventually give up and lose interest in learning mathematics.

Slow learners will know they would not manage to solve a task they deem very difficult. They will even hate you as a teacher because they will say this teacher does not know anything, but he wants us to be finding answers. … When you use problem solving, the challenges are that sometimes learners fail to achieve the goal. As a result, there will be no progress. (TC2)

In addition, TC2 saw the use of prior knowledge and skills to tackle a given task in a problem-solving lesson as a challenge. He stated that “When you [ask] learners to use the problem-solving approach they will have to use previously acquired knowledge in order to
solve new and unfamiliar situations”. He cautioned that students might not have this prior knowledge and skills, rendering the problem-solving approach less effective.

Teachers were also asked to describe the type of support they needed to make changes regarding the use of a problem-solving approach to teach mathematics. According to TA1, teachers needed to solve the task during the planning of the research lesson to enable teachers to assess the methods students would use:

The support, which we will need, will be that as the problems are given to the students we the teachers should solve the tasks before giving them to students. At least you will be able to see that the methods they are using are correct or not. The time given to the students is not enough. When those problems are solved maybe within forty minutes, you give them about five questions and those questions they might not be able to solve them. So, when we solve the problem, first of all, we would be able to know that if a teacher is able to solve these problems in these few minutes or in this allocated time then the students should be given extra time. (TA1)

According to TC2, two mechanisms were needed to help teachers use problem solving to teach mathematics. First, teachers needed adequate materials to use in problem solving. He suggested that the school administrators should provide the required materials. Second, teachers needed to be trained in the use of problem solving.

Sometimes we will say we use problem solving and yet we do not understand how it should be done. So if there can be a workshop or maybe a CPD to talk about how problem solving can be used in class and we really understand because the challenges we have as teachers is that we have these methods, talk of problem solving, investigations, discussion but we do not really understand them. Therefore, if you do not understand the approach then even using it is a problem. You end up using it wrong or you end up using it at a time when you are not supposed to use it. Therefore, we need maybe more meetings to talk about our teaching approaches that include problem solving. (TC2)

A typical Japanese Lesson Study involves the discussion of students’ strategies and solutions during the planning of the research and during the post-lesson discussion. According to TA1, teachers tried to anticipate student answers to the questions as a team, especially the questions the teacher would be solving as examples. He claimed that the lesson plan template had a column where teachers were required to write student responses, which included anticipated solutions (although this is not borne out by an inspection of the template):
There is pupil involvement activity, which is the column for the student's activity [on the lesson plan], talking about expected solutions from the students. What are the answers that we are expecting from the students and on the other side where we are looking at the solutions that might be from the students in comparison from what the teacher is able to do? (TA1)

TC2 claimed that teachers at School C made sure their mathematics lesson were learner-centred. He added, “We are able to apply problem-solving strategy, which focusses on individual learning. As we plan our lessons, we will make sure that the lesson will be learner-centred”.

7.4.3 Summary

According to teachers at School A, B and C, the school leadership supported lesson study by encouraging teachers to participate in lesson study, providing materials, timetabling lesson study activities, sending teachers to workshops for lesson study, and ensuring that teachers conducted the prescribed number of lesson study cycles each term.

Teachers claimed that collaboration among teachers had improved because of lesson study. Teachers were now free to consult one another and consider each other as equals. They felt they could also ask other teachers to teach “difficult” topics to their classes, which is not quite in the spirit of lesson study.

However, a teacher at School A expressed the view that collaboration among teachers was not very strong because some teachers had not accepted lesson study. This observation was confirmed by some of the observations at the schools. For example, planning sessions at School B were characterised by tensions between teachers. They could not agree when to teach the research lesson, they disregarded the directives given by the HOD, some saying, “yashani yo”, simply translated as “that’s nonsense”. Indeed, those who said “yashani yo” did not observe the research lesson. The HOD told the researcher that there was nothing she should do about the situation.

Teachers across the three schools were sceptical about using a problem-solving approach, stating that such lessons benefitted fast learners rather than slow learners and therefore should not be used in a class with many slow learners. During one of the meetings at School C, it emerged that teachers did not understand the meaning of different teaching approaches, such as inquiry, discovery, or problem solving and wanted professional development to help them understand the meaning.

Regarding the discussion of students’ strategies and solutions, both during the planning
of the research and reflections, teachers claimed that they did this. However, the observational data reveals that teachers did not do this.

7.5 Grade 12 examination results

While the Impact Assessment Reports of 2010 and 2015 reported on changes in Grade 12 examination results in mathematics in Central province over the period 2005 to 2009, and nationwide and for Central, Eastern and North-western provinces for the period 2009 to 2013, in order to complete the case studies at Schools A, B and C, a more detailed investigation of Grade 12 examination results in mathematics was carried out.

Chi-square statistics were computed for the results from each school to test for differences in student pass-rates based on the year of the examination.

At Schools A and B, data was collected for 2011 and 2014, while at School C, which only opened in 2014, data from the 2015 and 2016 examination results was used.

While the Grade 12 examinations are different each year, and there are no common items across years, it would seem a reasonable assumption that there were no major difference between years as the examination are based strictly on the curriculum for that year level.

However, caution needs to be exercised when interpreting the results obtained, given the fluctuation in the pass rates for both science and mathematics revealed by the trend analysis of the national examination results as shown in Figure 7.4.

7.5.1 Categorisation of Grade 12 examination results

The Examination Council of Zambia (ECZ) groups the Grade 12 examination results into nine divisions, which are grouped further into five categories as shown in Table 7.4 The “Unsatisfactory” category, constituting the score range 0-39, indicates a complete fail.

<table>
<thead>
<tr>
<th>Category</th>
<th>Division</th>
<th>Score out of 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distinction</td>
<td>One</td>
<td>75-100</td>
</tr>
<tr>
<td></td>
<td>Two</td>
<td>70-74</td>
</tr>
<tr>
<td>Merit</td>
<td>Three</td>
<td>65-69</td>
</tr>
<tr>
<td></td>
<td>Four</td>
<td>60-64</td>
</tr>
</tbody>
</table>

Table 7.4 Examination Council of Zambia categories for Grade 12 examination results (Source: ECZ, 2017)
Credit
Five
55-59
Six
50-54
Satisfactory
Seven
45-49
Eight
40-44
Unsatisfactory (Fail)
Nine
0-39

7.5.2 Student performance at School A

The Grade 12 examination results in mathematics for 2011 and 2014 at School A are summarised in Table 7.5 and Table 7.6. The first three rows in each table indicate the number of students with results in each division, while the next three show the same data represented as percentages.

Table 7.5 Grade 12 results by division for 2011 for School A (Source: ECZ, 2011)

<table>
<thead>
<tr>
<th>Sex</th>
<th>Divisions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One</td>
</tr>
<tr>
<td>Males</td>
<td>142</td>
</tr>
<tr>
<td>Females</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>168</td>
</tr>
<tr>
<td>Males %</td>
<td>39.23</td>
</tr>
<tr>
<td>Females %</td>
<td>16.88</td>
</tr>
<tr>
<td>Total %</td>
<td>32.56</td>
</tr>
</tbody>
</table>

Table 7.6 Grade 12 results by division for 2014 for School A (Source: ECZ, 2014)

<table>
<thead>
<tr>
<th>Sex</th>
<th>Divisions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One</td>
</tr>
<tr>
<td>Males</td>
<td>170</td>
</tr>
</tbody>
</table>

7.5.2 Student performance at School A

The Grade 12 examination results in mathematics for 2011 and 2014 at School A are summarised in Table 7.5 and Table 7.6. The first three rows in each table indicate the number of students with results in each division, while the next three show the same data represented as percentages.
Table 7.5 and Table 7.6 show that, of the 516 students who sat for Grade 12 mathematics examination in 2011, 198 (38.4%) failed the examination, and of the 628 students in 2014, 272 (43.3%) failed. The pass rates for mathematics between 2011 and 2014, therefore, show a decline at School A from 61.6% in 2011 to 56.6% in 2014.

Of the 516 students who sat the mathematics examination at School A in 2011, 70% were male, while of the 628 students who sat the mathematics examination in 2014, 66% were female. The pass rate for males declined from 67.1% in 2011 to 62.6% in 2014, while that of females declined from 62.6% in 2011 to 45.0% in 2014.

At School A, the results by category for both 2011 and 2014 are shown in Table 7.7.

<table>
<thead>
<tr>
<th>Year</th>
<th>Sex</th>
<th>Results by category</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Distinction</td>
<td>Merit</td>
</tr>
<tr>
<td>2011</td>
<td>Male</td>
<td>164</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>33</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>197</td>
<td>50</td>
</tr>
<tr>
<td>2014</td>
<td>Male</td>
<td>182</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>46</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>228</td>
<td>31</td>
</tr>
</tbody>
</table>

As can be seen in Table 7.7, the pass rate with Distinction declined from 38% in 2011 to 36% in 2014. Similarly, the pass rate with Merit declined from 10% (2011) to 5% (2014) and with Credit, from 8% (2011) to 7% (2014). However, the pass rate with Satisfactory
improved from 6% (2011) to 8% (2014), and the failure rate (Unsatisfactory) increased from 38% (2011) to 43% (2014).

The data in Table 7.7 were tested for the significance of these differences, between 2011 and 2014, using a Chi-square test. The null hypothesis was:

\[ H_0: \text{There is no difference in students' results based on the year} \]

The Chi-square statistic was 12.45, with 1143 degrees of freedom, and \( p = 0.01 \). Thus, the result is significant at \( p < .05 \), indicating a statistically significant decline in student performance.

### 7.5.3 Student performance at School B

The Grade 12 examination results in mathematics for 2011 and 2014 at School B are summarised in Table 7.8 and Table 7.9.

Table 7.8 and Table 7.9 show that, of the 641 students who sat for Grade 12 mathematics examination in 2011, 405 (63.2%) failed the examination, and of the 618 students who sat the examination in 2014, 272 (53.7%) failed. The pass rate for mathematics, between 2011 and 2014, shows an improvement at School B, as the performance of students in mathematics improved from 36.8% passing in 2011 to 46.3% passing in 2014. The pass rate by sex improved between the 2011 and 2014 for both males and females – from 46.9% in 2011 to 53.4% in 2014 for males and from 24.2% in 2011 to 34.9% in 2014 for females.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Divisions</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One</td>
<td>Two</td>
</tr>
<tr>
<td>Males</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>Females</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Males %</td>
<td>5.06</td>
<td>4.77</td>
</tr>
<tr>
<td>Females %</td>
<td>0.00</td>
<td>1.05</td>
</tr>
<tr>
<td>Total %</td>
<td>2.81</td>
<td>3.11</td>
</tr>
</tbody>
</table>

Table 7.9 Grade 12 results by division for 2014 for School B (Source: ECZ, 2014)

<table>
<thead>
<tr>
<th>Sex</th>
<th>Divisions</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7.8 Grade 12 results by division for 2011 for School B (Source: ECZ, 2011)
At School B the results by category for both 2011 and 2014 are shown in Table 7.10.

Table 7.10 Grade 12 results by category for 2011 and 2014 for School B (Source: ECZ, 2011, 2014)

<table>
<thead>
<tr>
<th>Year</th>
<th>Sex</th>
<th>Category</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Distinction</td>
<td>Merit</td>
</tr>
<tr>
<td>2011</td>
<td>Male</td>
<td>35</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>38</td>
<td>61</td>
</tr>
<tr>
<td>2014</td>
<td>Male</td>
<td>42</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>48</td>
<td>69</td>
</tr>
</tbody>
</table>

As can be seen in Table 7.10, the pass rate with Distinction increased slightly from 6% (2011) to 8% (2014). Similarly, the pass rate with Merit increased from 9% (2011) to 11% (2014); with Credit, from 10% (2011) to 14% (2014); and with Satisfactory, from 12% (2011) to 13% (2014). There was a reduction in failure rate (Unsatisfactory), from 63% (2011) to 34% (2014).

The results in Table 7.10 were tested for the significance of their differences, between 2011 and 2014, using a Chi-square test. The null hypothesis was:

\[ H_0: \text{There is no difference in students’ results based on the year} \]

The Chi-square statistic was 13.2, with 1258 degrees of freedom, and \( p = 0.01 \). Thus, the result is significant at \( p < 0.05 \), indicating a statistically significant improvement in student performance between 2011 and 2014.
7.5.4 Student performance at School C

School C is a girls’ school. School C had no data for 2011 and 2014 because it was a new school that opened in 2014 and there were no Grade 12 students until 2015. The Grade 12 examination results in mathematics for 2015 and 2016 at School C are summarised in Table 7.11.

As can be seen from Table 7.11, all 80 (100%) girls who sat for Grade 12 mathematics examination in 2015 passed, as did all 75 (100%) girls who sat Grade 12 mathematics examination in 2016.

Table 7.11 Grade 12 results by division for 2015 and 2016 for School C (Source: ECZ, 2017)

<table>
<thead>
<tr>
<th>Year</th>
<th>Division</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One</td>
<td>Two</td>
</tr>
<tr>
<td>2015</td>
<td>44</td>
<td>9</td>
</tr>
<tr>
<td>Total %</td>
<td>55.00</td>
<td>11.25</td>
</tr>
<tr>
<td>2016</td>
<td>35</td>
<td>12</td>
</tr>
<tr>
<td>Total %</td>
<td>46.66</td>
<td>16.00</td>
</tr>
</tbody>
</table>

At School C, the quality of results for both 2015 and 2016 is shown in Table 7.12.

Table 7.12 Grade 12 results by category for 2015 and 2016 for School C (Source: ECZ, 2017)

<table>
<thead>
<tr>
<th>Year</th>
<th>Results by category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distinction</td>
</tr>
<tr>
<td>2015</td>
<td>53</td>
</tr>
<tr>
<td>Total %</td>
<td>66.25</td>
</tr>
<tr>
<td>2016</td>
<td>47</td>
</tr>
<tr>
<td>Total %</td>
<td>62.67</td>
</tr>
</tbody>
</table>

As can be seen in Table 7.12, the pass rate with Distinction declined slightly from 66% (2015) to 63% (2016); while Merit increased from 19% (2015) to 20% (2016); Credit, increased from 9% (2015) to 11% (2016); and Satisfactory increased from 6% (2015) to 7% (2016). School C had 0% failure rate in both years.
The results in Table 7.12 were tested for the difference based on the year (2015 and 2016) using a Chi-square test. The null hypothesis was:

\[ H_0: \text{There is no difference in students' results based on the year} \]

The Chi-square statistic was 0.27, with 179 degrees of freedom, \( p = 0.97 \). The result is not significant at \( p < .05 \), indicating that there was no statistically significant difference in students’ results based on the year.

### 7.5.5 Comparing the pass rates between schools

The pass rate by category for Schools A, B and C in Year 1 (2011 for Schools A and B, and 2015 for School C) and Year 2 (2014 for Schools A and B, and 2016 for School C) are shown in

Figure 7.4 and Figure 7.5.

<table>
<thead>
<tr>
<th></th>
<th>School A</th>
<th>School B</th>
<th>School C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distinction</td>
<td>38.2</td>
<td>5.92</td>
<td>66.3</td>
</tr>
<tr>
<td>Merit</td>
<td>9.6</td>
<td>9.5</td>
<td>18.7</td>
</tr>
<tr>
<td>Credit</td>
<td>7.6</td>
<td>9.68</td>
<td>8.8</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>6.2</td>
<td>11.7</td>
<td>6.2</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>38.4</td>
<td>63.2</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 7.4. Results for Grade 12 mathematics at School A, B and C in Year 1
For both years, School C had the highest pass rate by Distinction (66.3%, in Year 1 and 62.7% in Year 2), followed by School A (with 38.2% in Year 1 and 36.4% in Year 2). The failure rate was higher than the pass rate at School B in both years. At School B, 63.2% failed the Grade 12 examination in mathematics in 2011 and 53.7% failed in 2014. School C had the lowest failure rate of 0% in both years.

In general, only School B showed improvement in student pass rates from 37% (2011) to 46% (2014). At School A, the pass rates for mathematics showed a decline from 62% (2011) to 57% (2014). The pass rate at School C remained the same for 2015 and 2016 – 100% in both years – although the data was only available for two consecutive years rather than over a three period as for Schools A and B.

It should be noted that although the differences in pass rates were statistically significant for School A and B, we cannot conclude that lesson study accounted for the differences as there may have been many other factors involved.

7.5.6 Summary

The Grade 12 examinations results showed that only School B, showed an improvement in student pass rate from 37% in 2011 to 46% in 2014. However, this was from a very low base compared to School A, where the pass rate, while declining from 62% in 2011 to 57% in 2014, was much higher. School C, where data was only available for 2015 and 2016 because it was a new school, had a 100% pass rate for both years.

Lesson study in mathematics was introduced at different times at the three schools –
in 2012 at School A, 2008 at School B, and 2015 at School C – and lesson study as observed was not implemented according to the Ministry requirements, particularly at School B where it was implemented in a most perfunctory way. As a result, lesson study should not be considered as accounting for the differences identified in the pass rates between the years at each school, as other intervening factors might account for the differences in the pass rates.

7.6 Conclusion

The Zambian Ministry of Education had expected the introduction of lesson study to deepen teachers’ knowledge and skills; improve their attitudes towards mathematics; and result in a shift from teacher-centred learning to more student-centred learning; and hence to improve student learning, especially as shown in national examination results.

The Ministry conducted two assessments of the impact of the introduction of lesson study, the first of which related almost exclusively to science. According to the second impact assessment, there was a significant improvement in both Science and Mathematics results at Grade 12 in two of the three provinces surveyed, while in the third province there was a “marginal improvement”. Based on self-reported levels of implementation of lesson study, a statistically significant positive correlation was found between the level of implementation and student pass rates. However, this claim should be taken with caution as correlation does not mean causation – see, for example, Gravetter and Wallnau (1992) who state that “a correlation should not and cannot be interpreted as a proof of a cause-effect relation between two variables” (p. 477) – while many teachers also reported that they believed there could be contributing factors other than lesson study. Analysis of the teacher and student questionnaires, also found a high proportion of respondents to have reported improved attitudes towards mathematics.

The in-service providers described many of the same effects as those stated in the Impact Assessment Report of 2010 and the Impact Assessment Report of 2015. This was not surprisingly as some of the interviewees had been involved in the studies that formed the basis for these reports. However, one participant raised the issue of lesson study sustainability in provinces where lesson study had been first implemented, which resonated with the observations at the three schools where School B performed the least well in terms of adherence to the requirements set by the Ministry and yet was among the first schools where lesson study was implemented in Zambia.
School administrators claimed that collaboration among teachers had improved, and that lesson study had increased teachers’ confidence in teaching and being observed by their colleagues. Again, while some administrators were confident that lesson study had brought about improvements in students’ test results, one CPD co-ordinator was sceptical that students were doing better in mathematics because of lesson study stating that school administrators lacked effective tools to measure the effect of lesson study on pass rates.

The teachers of mathematics reported many positive effects of lesson study. They claimed that collaboration among teachers had improved because of lesson study, with teachers were now feeling free to consult one another and ask for help in teaching “difficult” topics. However, one teacher disagreed, stating that some teachers had not accepted lesson study, which was confirmed by observations at the schools where at times there was overt antagonism displayed. Teachers across the three schools were sceptical about using a problem-solving approach, stating that such lessons benefitted fast learners rather than slow learners and therefore should not be used in a class with many slow learners, with some teachers also commenting that they needed professional development in order to understand what was meant by problem solving and other teaching methods and how they were meant to be implemented. While some teachers claimed that discussion of students’ strategies and solutions was part of their planning and reflections, the observational data contradicts this claim.

The investigation of the Grade 12 examination results in mathematics provided no conclusive results. At School A, where lesson study was introduced in 2012, there was a significant decline in student performance between 2011 and 2014, while at School B, where lesson study in mathematics had been introduced in 2008 and where its implementation was the weakest among the schools observed, there was a significant improvement in the results between 2011 and 2014, albeit from a very low base. At School C, where lesson study was introduced in 2015, there was no change in the 100% pass rate between 2015 and 2016.

Overall, there seems to be a wide discrepancy between the reported positive effects of lesson study and the observational data obtained in this study. This is examined further in the following chapter.
Chapter 8  Discussion and Conclusion

As stated in Section 2.5 of this thesis, this study addresses the following overarching research question:

*RQ:* How is lesson study in mathematics being implemented in Zambia?

This question was addressed through the following subsidiary questions, which formed the basis for Chapters 4, 5, 6 and 7 respectively:

*SQ1:* How is lesson study in mathematics defined by the Zambian Ministry of Education, and interpreted by in-service providers, school administrators, and teachers of mathematics?

*SQ2:* What mechanisms have been put in place to support lesson study?

*SQ3:* How is lesson study being implemented at the school level?

*SQ4:* What has been the effect of the implementation of lesson study in mathematics in Zambia?

This chapter draws on the findings related to the subsidiary questions in order to address the overarching research question that underpins this research.

8.1  The introduction of lesson study in Zambia

Lesson study was first introduced in Zambia in 2005 with the help of the Japanese International Cooperation Agency (JICA) through the *Strengthening Mathematics, Science and Technology Education* (SMASTE) programme, at a time when the 2002 introduction of free basic education (Grades 1 to 9) had resulted in significant increases in enrolment rates and a shortage of qualified teachers, especially in science and mathematics.

Phase I (2005-2007) of the programme saw lesson study introduced to Grade 8-12 science teachers in Central Province. In Phase II (2008-2011), the programme was extended to all teachers in Central Province and Grade 8-12 science teachers in Copperbelt and Northwest Provinces. During this period, the Zambian Ministry of Education, together with JICA, developed the *Teaching Skills Book* (MOE & JICA, 2009) and the *Implementation Guidelines* (MOE & JICA, 2010). Based on the experiences from these two pilot programmes, the *Strengthening Teachers’ Performance and Skills through School-Based Continuing Professional Development* (STEPS) programme introduced lesson study, in all subject areas,
in all ten provinces of the country in November 2011.

Mathematics education had undergone several reform attempts since Zambia’s political independence in 1964, with the Ministry of Education identifying three primary areas of mathematics education as requiring reform: teacher-centred instruction, the mathematics curriculum, and continuing professional development of mathematics teachers (MOE, 1996).

Regarding curriculum reform, the Ministry of Education’s Strategic plan 2003 – 2007 sought to reform the curriculum at basic, high school and tertiary levels in order to provide relevant skills and knowledge, and sufficient learning and teaching materials for all levels (MOE, 2003), with the Ministry of Education claiming that it had succeeded in revising the curriculum for Basic Education by 2007 (MOE, 2014).

The introduction of lesson study was expected to assist in the reform efforts by: deepening teachers’ knowledge and skills; improving teachers’ attitudes towards mathematics; transforming the persistent teacher-centred lessons into student-centred lessons; and, as a result, improving student learning, especially as evidenced by national examination results (MOE & JICA, 2009, 2010a, 2010b; MESVTEE & JICA, 2015).

8.2 Lesson study in Zambia

The lesson study model for Zambia was based on Japanese Lesson Study (JLS) and was developed with input from JICA. However, according to MOE (2010), the Japanese Lesson Study model was modified to suit the Zambian school context.

The main publications defining the Zambian model of lesson study are the Teaching Skills Book (MOE & JICA, 2009) and the Implementation Guidelines (MOE & JICA, 2010b). These publications give advice on all aspects of the implementation of Zambian lesson study, including detailed advice on lesson planning, teaching approaches to transform teacher-centred lessons into student-centred lessons, and the difference between “good” and “bad” lesson plans. They also include the Zambian eight-step lesson cycle model (MOE & JICA, 2010b, p. 8), which can be found in Figure 4.2 in this thesis.

This section compares various aspects of Zambian lesson study with Japanese lesson study and discusses how faithfully the observed lesson study cycles at the three case schools followed the Zambian model.

8.2.1 The Zambian eight-step lesson cycle

One obvious difference between the Zambian model of lesson study and JLS is the
fact that the Zambian eight-step lesson cycle model mandates revising and reteaching the research lesson. Seleznyov (2018) in her review of 97 studies of implementation of lesson study outside Japan, exploring their degree of fidelity to the Japanese model, states that “In terms of revising or reteaching the same lesson to a different class, the literature diverges [with] the weight of evidence therefore suggest[ing] that reteaching is not part of JLS” (p. 220). By way of contrast, Fujii (2014, pp. 76–77) claims that reteaching the lesson to a different class ignores the fact that the students will be different. He cites the Zambian eight-step model, which he believes would be difficult to change. However, Huang and Shimizu (2016) state that in Japan revision and reteaching of the research lesson is optional. This it appears that reteaching the research lessons is contested in Japan.

Observations in the three case schools confirmed that it was normal practice to follow this aspect of the Zambian eight-step cycle, even though at School C it was decided that it was unnecessary to reteach the second research lesson as teachers decided that all the objectives had been met.

### 8.2.2 Goals for lesson study

An important feature of the process of school-based JLS is the development of a long-term goal for student learning that becomes the research theme (or question) to be addressed throughout the lesson study at that school. According to Huang and Shimizu (2016), lesson study requires participants to “have a research question …, design a research lesson, teach the research lesson to test design regarding research question, reflect and revise the research lesson, repeat the cycle until the research question has been addressed to a certain extent” (p. 400). Seleznyov (2018) also regards this as one of the critical components of JLS, stating that teachers should focus on comparing “long-term goals for pupil learning and development to pupils’ current learning characteristics in order to identify a school-wide research theme, which may be pursued for two or three years” (p. 220), but reports that of the 97 studies of lesson study implementation outside Japan in her review, 33% did not include the identification of a research theme.

In Zambia, the Ministry treats the national goals for education as the long-term goal of lesson study, stating that the goal of lesson study is “to realize a Learner-Centred Lesson by applying multiple teaching/learning approaches to the learners” (MOE & JICA, 2010b, p. 3), with no suggestion that teachers participating in lesson study should be developing school-wide (or even department-wide) research goals that focus on student learning rather than teacher actions.
However, in terms of the rationale for research lessons, the *Teaching Skills Book* states that the four basic components are: Content (what is to be taught); Concept/value (why it should be learned); Methods (used to deliver the lesson); and Location (position in the sequence of lessons in a unit) (MOE & JICA, 2009, p. 11). During the observations at the case schools, the second component of the rationale led, at times, to some interesting discussions about how to demonstrate the value or relevance of some abstract mathematical topics to students.

Lesson objectives, on the other hand, are defined in the *Teaching Skills Book* as “specific statements which set out what pupils are expected to learn from a particular lesson in a way that allows the teacher to identify if learning has occurred”, with teachers required to write lesson objectives in a “behavioural way so that teachers and pupils [students] are able to find if they [objectives] had been attained in a lesson” (MOE & JICA, 2009, p. 11). As a consequence, most objectives for the observed research lessons included statements such as the following from lesson 1 at School B: “At the end of the lesson, students should be able to calculate average speed, time and distance. Acceptable performance is getting 3 questions correct out of 5 questions of an exercise”.

Discussing constraints and challenges related to effective lesson study, Huang, and Shimizu (2016) point out that “a school and classroom culture that emphasizes the standard examination-oriented evaluation may further constrain teachers from pursuing long-term goals of student learning” (p. 401).

### 8.2.3 Teaching approaches

A common feature of Japanese mathematics lessons (particularly research lessons) is that they follow a pattern that has been described as “structured problem solving”, comprising: the presentation of a single problem; individual or group problem solving by students; whole-class discussion of students’ solutions; and a summary by the teacher (Shimizu, 1999). In fact, the world-wide interest in lesson study has been partially attributed to Stigler and Hiebert’s (1999) accounts of Japanese structured problem-solving lessons based on the *Third International Mathematics and Science Study* (TIMSS) video study.

In Zambia, teachers are advised to use a mixture four teaching approaches (Mastery Learning, Inquiry-Discovery, ASEI/PDSI – which focusses on practical hands and minds-on activities, particularly in science – and Problem Solving) with their use depending on the context, student characteristics, and the availability of materials (MOE & JICA, 2009, p. 15). Nevertheless, one of the five essential characteristics listed for the lesson development is that it “supports problem solving climate of learning” (p. 15). Similarly, the *Implementation*
Guidelines states that lesson study promotes “a variety of teaching strategies with a focus on stimulating learning through inquiry, guided-discovery, problem-solving, application, and similar activity-based teaching and learning” (MOE & JICA, 2010b, p. 7).

The Teaching Skills Book describes a problem-solving approach as giving the main problem to students and letting them find the solutions, letting students interact with one another and with the teacher, and letting students discuss and draw conclusions from their findings. The teacher takes the role of a facilitator.

However, this study found that actual practice differs from this conceptualisation of a problem-solving approach. None of the lessons observed could have been described as using a problem-solving or inquiry-discovery approach. There was also a consensus among the teachers interviewed at the three case schools that using a problem-solving approach was a challenge, with teachers stating various reasons, including the belief that such lessons benefitted fast learners rather than slow learners and therefore should not be used in a class with many slow learners. Teachers also indicated that they did not understand how to implement problem-solving and wanted professional development in this area.

Furthermore, during one of the planning sessions observed, after some discussion regarding the methods to be used to deliver the lesson, teachers decided they did not understand the distinctions between these different methods such as inquiry and problem solving and wanted professional development on what they meant, a suggestion the HOD noted and promised to follow up.

8.2.4 Investigating a wide range of instructional material

In Zambia, the Teaching Skills Book recommends the investigation of a wide range of instructional material when planning a research lesson. These materials include: the curriculum, reference books, past lessons plans, and pedagogical articles produced by other teachers who have attempted to solve similar problems (MOE & JICA, 2009, p. 10).

This emphasis on investigating a wide range of instructional material is similar to Japanese kyozaikenkyu – a rigorous and intricate investigation of a range of instructional materials, including textbooks, curriculum materials, lesson plans and reports from other lesson studies, coupled with a study of students’ prior understandings – which is widely recognised as one of the critical components of lesson study (see, for example, Takahashi & McDougal, 2016; Seleznyov, 2018). According to Watanabe, Takahashi, and Yoshida (2008), the aim of kyozaikenkyu is to match the mathematical goals of the lesson with the specific tasks to be used, and with students’ prior knowledge.
However, Ministry Officers, other in-service providers, and school administrators, when interviewed did not mention that teachers should spend significant time on investigating a wide range of instructional material. While the suggested time allocation for the collaborative planning of the research lesson is 2 to 3 hours (MOE & JICA, 2010b, p. 21), the average time actually spent on the lesson planning at the three case schools was just under an hour, which was far less than recommended. The only instructional materials investigated were student textbooks and, on one occasion, the New Mathematics Curriculum, but only to confirm the correct grade level for the topic chosen.

8.2.5 The lesson plan

In Japan, developing the lesson plan involves considerable collaborative work, which according to Fujii (2016) is largely under-appreciated by non-Japanese adopters of lesson study. Usually, teachers hold more than one planning meeting, mostly with the first meeting having no draft lesson plan. At all other meetings, teachers base their discussions on a draft lesson plan.

The major differences between the structure of the typical Japanese lesson plans, as illustrated in Chapter 2, and that recommended for Zambian lesson plans in the Teaching Skills Book are the absence of any mention of a research theme in the Zambian version, the lack of a detailed plan for the unit of work in which the research lesson is located, and explicit discussion of anticipated student solutions. While the sample template has just 3 pages, the Teaching Skills Book attempts to show how a lesson plan can demonstrate a teacher-centred focus as opposed to a student-centred focus by providing a (science) example of a “bad” and a “good” description of the lesson, where the “good” plan clearly includes anticipated student solutions, across a range of possibilities (MOE & JICA, 2010b, pp. 4–5).

During the observations at the case schools, a number of different templates were used, including two different ones at one of the schools., with a number of items missing from the Ministry template from some – for example, one had no rationale, and one had no lesson conclusion. At one school, a teacher said he couldn’t include something the planning team wanted to include because there was no more room on the sheet. Using the hard copy lesson template seems to have sent wrong signals to teachers, treating the template as a form requiring less than one hour to be filled. Moreover, filling in blank spaces on the lesson plan template led to suspension of discussions on several occasions to give the teacher enough time to capture what to write on the template.
8.2.6 Observing the research lessons

According to Lewis and Tsuchida (1998), a key feature of lesson study in Japan, is that they are observed by an audience of other teachers, as well as sometimes a few invited outside commentators, with Fernandez (2002, p. 400) commenting that teachers “clearly understand the importance of articulating for themselves, and others, exactly what they want to look for to make their observations productive”. Therefore, according to Chokshi and Fernandez (2004), the research goal of a lesson study group should include questions to be investigated and the guidelines for observing the lesson.

As is the case in Japan, the focus of observation of the research lessons in Zambia is expected to be on students’ learning. According to the Teaching Skills Book (MOE & JICA, 2010b, p. 33), observers should not sit at the back of the classroom as this would result in focussing on the teaching rather than the learning and not see students’ facial expressions. Observers are also advised to have specific areas of observation to help with the post-lesson discussions.

However, the findings from the case studies showed that detailed observation of student learning during research lessons was not yet an ingrained practice for lesson study participants.

At School A, the HOD gave members of the planning team a checklist for recording their observations, reminded them that each observer should take notes during the lesson to help evaluate and revise the lesson. Nevertheless, the HOD was the only participant who took notes or used the checklist, and only the HOD stood up to observe students working, although one observer stood up to talk to the teacher during the lesson.

At School B, while a total of eight people, including two pre-service teachers, took part in the first planning session, only the HOD, two pre-service teachers, and one other teacher observed the research lesson; the lesson was re-taught by a different teacher, who had taken part in the planning but had not attended the actual lesson: and only the HOD and the two pre-service teachers attended the revised lesson. Only the HOD, the teacher who was meant to teach the lesson, and the two pre-service teachers took part in the second planning session. The research lesson was taught by a different teacher and only the HOD attended.

By way of contrast, at School C, six of the eight mathematics teachers took part in all phases of the two lesson study cycles, while the Deputy Headteacher also attended research lesson 1 and the subsequent revision session. During the first planning session there was no discussion of what observers would be doing during the teaching of the lesson and three
observers walked around the class marking students’ books and helping those who had difficulties, while the others stayed seated throughout. During the revision session the Deputy Headteacher pointed out that the role of observers was to see how the lesson unfolds in class rather than mark books or engage in teaching students. As a result, during the second research lesson, some of the observers took notes while sitting at the back of the classroom.

8.2.7 The duration of lesson study

The Implementation Guidelines specified that lesson planning, revision of the taught lesson and the post-lesson discussion should be held “during the school day, outside teaching time, while lesson demonstrations should be conducted during lesson time so that the developed lessons are tried in an actual class” (MOE & JICA, 2010b, p. 18), which is very similar to the process in Japan.

However, according to the Implementation Guidelines, an entire lesson study cycle, including the preparation for the research lesson, teaching and revising the first research lesson, teaching the revised lesson, and the post-lesson discussion, should be completed within five days. This contrasts with Japanese practice, with Fujii (2014) stating that one of the characteristics of Japanese Lesson Study is that “it sometimes takes more than half a year to design a task and plan a lesson” (p. 68).

Figure 8.1 shows the times for each step of the lesson study cycle as recommended in the Implementation Guidelines (MOE & JICA, 2010b, pp.20–22) and contrasts this with the actual duration for each step, other than Step 8 which was not observed.

Each of the six lesson study cycles that were observed at schools A, B, and C were completed in less than two days, with School A completing each cycle in a single day.

As can be seen in Figure 8.1, the time spent on the planning meetings and the reflections was much less than that recommended in the Implementation Guidelines and the Teaching Skills Book. In the case of School A, the planning team, without a draft lesson plan at the start of the meeting, spent just 34 minutes planning research lesson 1, instead of the recommended 120 to 180 minutes, while the average time spent on planning the six research was less than one hour. At School A, the planning sessions also impinged on the amount of time available for teaching the research lessons as the planning sessions started late and were scheduled in the teaching period immediately before the research lesson.

Even when the time devoted to planning was approximately one hour, the time devoted to reflecting on and revising the lesson and the post-lesson discussions was extremely short – an average of just 22 minutes total for reflecting on and revising the lesson and 11
minutes for the post-lesson discussion, and the former included one meeting of over an hour, but just between the HD and the teacher who taught the lesson.

Figure 8.1. The time each case school spent on each step of the lesson study cycle

<table>
<thead>
<tr>
<th>Step</th>
<th>Activity</th>
<th>Recommended duration*</th>
<th>Actual duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>School A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>L 1</td>
</tr>
<tr>
<td>1</td>
<td>Defining the problem or challenge</td>
<td>1 – 2 hours</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>Collaboratively planning the lesson</td>
<td>2 – 3 hours</td>
<td>34</td>
</tr>
<tr>
<td>3</td>
<td>Implementing the demo-lesson</td>
<td>40 mins or 80 mins</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Discuss &amp; reflect on the lesson</td>
<td>1 – 2 hours</td>
<td>13</td>
</tr>
<tr>
<td>5</td>
<td>Revise the lesson</td>
<td>1– 2 hours</td>
<td>–</td>
</tr>
<tr>
<td>6</td>
<td>Teach the revised lesson</td>
<td>40 mins or 80 mins</td>
<td>40</td>
</tr>
<tr>
<td>7</td>
<td>Discuss the lesson and reflect on its effects again</td>
<td>1– 2 hours</td>
<td>17</td>
</tr>
<tr>
<td>8</td>
<td>Reflections compiled &amp; shared*</td>
<td>1 – 2 hours</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Total time (hours)</td>
<td>8 – 16</td>
<td>2</td>
</tr>
</tbody>
</table>

Notes:
* As recommended in the Implementation Guidelines (MOE & JICA, 2010b, pp.20 –22)
* This step was not observed in the case schools

The fact that planning for research lessons, reflection and revision sessions, and post-lesson discussions were conducted during school hours meant that teachers felt that lesson study took away teaching time needed to cover the New Mathematics Curriculum, which was what their performance as a teacher was judged on (e.g., Baba & Nakai, 2011; Banda, Mudenda, Tindi & Nakai, 2014; MOE & JICA, 2010a, ; Sinyangwe, Billingsley & Dimitriadi, n.d.).

This issue of teachers wanting to refrain from lesson study due to their busy schedules is not only found in Zambia. For example, White and Southwell (2003) stated that in New
South Wales, (Australia) it was difficult to find a suitable time for lesson study.

This finding suggests that teachers need adequate information about lesson study, and a deep understanding of its real benefits. If their understanding of lesson study is simply ideological and not pragmatic, they might participate in lesson study activities superficially (see, for example, Chokshi & Fernandez, 2004; Perry & Lewis, 2009; Stigler & Hiebert, 2016).

8.2.8 The involvement of a knowledgeable other

According to Takahashi and McDougal (2016), one of the essential features of effective lesson study is the involvement of knowledgeable others who contribute insights throughout the process. They define a knowledgeable other as someone from outside the planning team with deep expertise in the content, often deep expertise in teaching, and a great deal of experience with lesson study. The knowledgeable other provides final comments, sometimes lasting over 30 minutes, at the end of the post-lesson discussion (Fujii, 2016; Takahashi, 2014). Another knowledgeable other may also be involved during the planning phase, drawing attention to key issues. According to Fernandez et al. (2001), a knowledgeable other participates in lesson study to provide a different perspective on the lesson study work of the group, and to provide information about the subject matter, new ideas, or reforms. They also share the work from other lesson study groups.

According to the Implementation Guidelines, external experts include education standards officers, lecturers from colleges of education and universities, and lesson study facilitators. The role of a lesson study facilitator in Zambian lesson study goes beyond observing the demonstration lesson: facilitators should participate in lesson planning, check the lesson plan before the lesson is conducted, observe the demonstration lesson, facilitate discussions after the lesson, and prepare and submit the facilitation report (MOE & JICA, 2010b, p. 24). However, there is no suggestion that they should offer concluding comments in post-lesson discussions.

This study found that Zambian schools do not have a custom of inviting an expert to their research lessons to play the role of knowledgeable other, thus losing the opportunity to gain valuable insights.

As stated in Chapter 4, the experts who could be considered as knowledgeable others in Zambia were teacher educators from colleges and universities. However, their roles in lesson study usually appeared to involve collecting second-hand information about lesson study in schools during workshops.

According to Takahashi and McDougal (2016), the source of knowledgeable others
for research lessons is not limited to experts from colleges and universities. They claim that besides having extensive knowledge of the subject matter and the topic, knowledgeable others should be familiar with the school’s curriculum and students. Therefore, an experienced teacher or a content coach who often works at a school may play this role. They state that “As teachers deepen their knowledge of content through lesson study, we expect that they will be able to provide this service to each other” (Takahashi & McDougal, 2016, p. 521).

In this sense, the CPD facilitators described in the Implementation Guidelines could play the role of knowledgeable others if their roles were redefined. Facilitators “are classroom teachers or teacher educators who have been identified as focal persons in a given cluster or zone. Each facilitator shall be required to assist school-based CPD activities not only in his/her school but also some schools assigned to him/her” (MOE & JICA, 2010b, p. 23).

The statements in the Implementation Guidelines that lesson study facilitators should play the role of knowledgeable other needs to be regarded with caution. This is one of the most critical aspects of lesson study and one of the most difficult roles to carry out because, to provide effective final comments, one needs many “years of experience as practitioners of lesson study and by observing many, many research lessons and final comments by colleagues and experts” (Takahashi, 2014, p. 14). In the same vein, Baba and Nakai (2011) recommend that “subject-based practical wisdom … should be nurtured … [through the] establishment and accumulation of the subject-based practical wisdom and/or research, … [and the] formation of subject-based education specialists” (pp. 61–62).

Conducting research lessons without knowledgeable others does not only happen in Zambia, as similar approaches have been identified elsewhere. For example, Takahashi and McDougal (2016) reported that research lessons without a knowledgeable other are carried out in many lesson study projects in the USA. They argued that because of this, teachers do not get full reported benefits from the lesson study.

A careful look at the Onion Rings Model reveals that outside experts or knowledgeable others might not materialise across a system at the same time as the programme that needs them is being rolled out. It is also doubtful that in-service providers including people in the Ministry and universities in Zambia could be playing this role more effectively. The means of learning about lesson study seem inadequate. For example, the three-day workshops for facilitators of lesson study and the visits to Japan and by JICA people to Zambia have not as yet successfully “cascaded down” to the level of school implementation of lesson study.
8.2.9 The mathematical focus of the lesson study cycles

As stated earlier, a key aim for the introduction of lesson study in Zambia was to transform teacher-centred lessons into student-centred lessons. The evidence from the observations at Schools A and B suggests that the mathematical focus of the research lessons was more on the correctness of the answers to the tasks than eliciting student mathematical thinking. Typically, students were expected to be attentive and listen to the teacher, respond to verbal questions, seek clarification from the teacher when needed, copy notes, perform calculations, and attempt tasks in their notebooks or on the chalkboard. Occasionally students were expected to participate in discussions, particularly about other students’ solutions as demonstrated on the chalkboard.

However, at School C, while the lesson plans might suggest a focus on correct answers, there was frequent robust discussion during planning meetings of potential challenges for teachers – such as how to find real-life situations where apparently abstract mathematics was useful. It was also obvious in all lessons at School C that the teachers involved were not satisfied with students just getting the correct answers. Instead students who were asked to present their solutions before the class were asked to explain their thinking, and regularly included their classmates in their presentations, suggesting that students expected to look beyond the “correct answers”.

A disturbing feature of some of the research cycles was the fact that teachers did not always seem to have sufficient knowledge of the mathematics they were teaching or of the New Mathematics Curriculum.

8.2.10 Opportunities for professional development

As stated earlier, one of the three primary areas of mathematics education identified by the Ministry of Education as requiring reform was teachers’ continuing professional development. The lesson study cycles observed at the three case schools offered a number of opportunities for teachers to develop professionally. These included opportunities for teachers to develop their skills and knowledge of mathematics – for example, through the question raised by one teacher during the post-lesson discussion about the (incorrect) method used by one student to construct pie charts – and, to a lesser extent, the content of the New Mathematics Curriculum, which was only consulted once during the observations, but which should have been consulted when it became apparent in one planning meeting that teachers were uncertain of what to expect in the way of students’ prior knowledge.
Teachers were also exposed to strategies for making their lessons more student centred, with instances of teachers giving advice during revision sessions on the types of questions they could use to increase student involvement. During one planning meeting teachers discovered that they didn’t know the meaning of different teaching “methods” such as discussion, problem solving, inquiry and guided discovery, and asked the HOD to arrange for professional development in this area. One of the pre-service teachers, who attended a lesson study cycle, when asked what they had learned claimed an increased understanding of how to introduce the mathematical content, while the other pre-service teacher commented on the need to allow students to participate more.

However, many potential opportunities for teacher professional learning were not realised due to the lack of adequate time for planning at School A, and for the revision sessions and the post-lesson discussions at Schools A and B, as well as the fact that at School B only once did any teacher other than the HOD, the teacher teaching the lesson, and two pre-service teachers attend the research lessons or subsequent discussions.

8.2.11 Summary

The Zambian model of lesson study, which was developed with the assistance of JICA, was claimed to be a modified version of JLS. Nevertheless, most aspects as described in the Ministry documents were essentially faithful to the Japanese version. However, implementation of lesson study at the school level revealed a lack of fidelity to the Zambian model.

Table 8.2 expands Table 4.1 in this thesis by including a comparison of the implementation of lesson study as observed at the three case schools with both the Japanese Lesson Study and the Zambian model. It summarises the discussion in the previous sections of this chapter.
**Figure 8.2 A comparison of Japanese Lesson Study with the Zambian model and its observed implementation**

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Japanese Lesson Study</th>
<th>Zambian model of lesson study</th>
<th>As observed in Schools A, B and C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps in the lesson study cycle</td>
<td>• Four steps</td>
<td>• Eight steps including reteaching the research lesson</td>
<td>• Followed 8 steps, except for Lesson 2 at School C, where research lesson was not retaught.</td>
</tr>
<tr>
<td>Duration of a lesson study cycle</td>
<td>• More than five weeks</td>
<td>• Five days at the most</td>
<td>• School A completed each lesson study cycle in one day. School B and C completed each cycle in two days.</td>
</tr>
<tr>
<td>Setting goals for lesson study</td>
<td>• In a school-based lesson study, align research goals with those of the school</td>
<td>• Align goals with those of the Ministry of Education</td>
<td>• Ministry goals were not discussed in any of the six research lessons.</td>
</tr>
<tr>
<td></td>
<td>• Embedding research lesson in curriculum</td>
<td>• Rationale focussed on content, value, methods and location of lesson in unit</td>
<td>• Value rationale discussed in two lessons; methods discussed in one lesson, location only in terms of position in sequence</td>
</tr>
<tr>
<td></td>
<td>• Long-term goals</td>
<td>• Lesson objectives should be written in a behavioural way</td>
<td>• Objectives written in terms of mathematical skills</td>
</tr>
<tr>
<td>Investigating instructional materials</td>
<td>• Rigorous investigation of a range of instructional materials (kyozaikenkyu)</td>
<td>• Plan carefully for each lesson</td>
<td>• New Mathematics Syllabus was not investigated. Only School B used it but only to confirm the Grade level for research Lesson 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Plan by looking at the available resources</td>
<td>• Students’ textbooks were used at schools B and C to select student tasks.</td>
</tr>
<tr>
<td>Lesson plan</td>
<td>• A typical template for a lesson plan contains 5 items.</td>
<td>• A template for a lesson plan contains 16 items</td>
<td>• Each school had adapted the lesson plan template. The template used by School A did not have the section for Rationale.</td>
</tr>
<tr>
<td></td>
<td>• Maybe 9 pages</td>
<td>• Sample lesson plan appended in the Implementation Guidelines had 3 pages</td>
<td>• At School B, the template was not consistent between the two research lessons. Lesson 1 did not have a Conclusion Section.</td>
</tr>
<tr>
<td>Approaches used for delivering research lesson</td>
<td>Observing the research lesson</td>
<td>Participation of a knowledgeable other</td>
<td>Sharing lesson study results</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-----------------------------</td>
<td>---------------------------------------</td>
<td>-------------------------------</td>
</tr>
</tbody>
</table>
| • Research lessons in mathematics typically use structured problem solving | • Observers collect data on how the lesson affects students  
• Lesson observation focuses on teaching and learning processes.  
• Focus on how students responded to the lesson | • Schools invite a knowledgeable other  
• Final comments are given by the knowledgeable other | • Teachers write a booklet or long summary report by the end of the school year |
| • Teachers should mix four approaches | • Members of the planning team observe and evaluate the lesson.  
• Each observer should focus on assigned points  
• Focus is on students not teacher | • External experts include Ministry of Education officers.  
• No suggestion that experts provide final comments | • Lesson study reflections are compiled and shared  
• DEST summarises the reports from schools and shares at the next Stakeholders’ Workshop.  
• Outstanding practices in lesson study are shared widely |
| • The approach involved solving an example task, followed by students tackling the exercise based on the sample solution. | • At School A and C, members of planning team observed the lessons. However, at School Those who planned did not want to observe the lesson.  
• Observers were not assigned points of focus.  
• At School B during both L1 and L2, and School C during L1, observers marked students evaluation exercise. | • This expectation was not reached because those trained in lesson study were involved in rolling out the programme to the 10 provinces. | • Not observed |
8.3 Effects of lesson study

According to the Zambian Ministry of Education, the introduction of lesson study was expected to: deepen teachers’ knowledge and skills; improve teachers’ attitudes towards mathematics; and result in a shift from teacher-centred learning to more student-centred learning. As a result, the implementation of lesson study was expected to improve student learning, especially as evidenced in national examination results (MOE & JICA, 2009, 2010a, 2010b; MESVTEE & JICA, 2015).

Findings in this study related to the effects of lesson study are based on an analysis of key publications of the Ministry of Education, interview data, observations at schools A, B and C, and results from Grade 12 Mathematics national examinations. However, there were no direct observations of regular classroom practice at the three case schools.

8.3.1 The impact assessments

The Ministry conducted two assessments of the impact of the introduction of lesson study, the first of which related almost exclusively to the teaching of science in Central Province, where lesson study was first introduced in Grades 8 to 12 science in 2005 (MOE & JICA, 2010a). A difference-in-difference analysis of pass rates for national examinations in Grade 12 before and after the lesson study intervention found that by 2009 the pass rates for science and biology in Central Province exceeded those in the non-target provinces by 12.4% and 19.2%, respectively, with both of these differences being statistically significant at the $p < 0.01$ level. However, according to MOE and JICA (2010a) the focus on capacity development of facilitators and teachers in science also appeared to contribute to the increase in pass rate.

While lesson study in mathematics was only introduced in Central Province in 2008, the Impact Assessment Report of 2010 (MOE & JICA, 2010a) also compared the pass rate in mathematics between Central Province and the non-target provinces. No statistically significant difference was found, leading the authors to the unwarranted conclusion that “This indicates that tangible impact on the pupils’ achievement became evident after a certain period of the … intervention at the school level” (MOE & JICA, 2010a, p. 7).
The Impact Assessment Report of 2015 (MESVTEE & JICA, 2015, p. 19) addressed the effect of lesson study on both science and mathematics in three provinces – Central, North-western and Eastern. According to the second impact assessment, there was a significant improvement in both Science and Mathematics results at Grade 12 in two of the three provinces surveyed, while in the third province there was a “marginal improvement”.

Based on self-reported levels of implementation of lesson study, a statistically significant positive correlation was found between the level of implementation and student pass rates. However, this claim should be regarded with caution as correlation does not mean causation (see, for example, Gravetter & Wallnau, 1992) – while many teachers also reported that they believed there could be contributing factors other than lesson study for improvements in the pass rate.

Analysis of the teacher and student questionnaires, also found a high proportion of respondents to have reported improved attitudes towards mathematics. However some of the claims, such as 94% of teachers claiming that they were able to think deeply about long-term goals, or that 91% of teachers were able to testify that lesson study had changed their attitudes in terms of the way they perceived some topics, also need to be regarded with caution as there was no evidence supporting these findings provided anywhere in the report.

8.3.2 The interviews with in-service providers, school administrators and teachers of mathematics

The in-service providers described many of the same effects as those stated in the Impact Assessment Reports. However, one participant raised the issue of lesson study sustainability in provinces where lesson study had been first implemented, which resonated with the observations at the three schools where School B performed the least well in terms of adherence to the requirements set by the Ministry and yet was among the first schools where lesson study was implemented in Zambia.

However, a Ministry Officer raised the issue of lesson study sustainability in provinces where lesson study was first implemented. This view seems to be supported by the six lesson study cycles observed at School A, B, and C. Among the three schools, B performed the least well in terms of adherence to the requirements set by the Ministry and yet it was among the first schools where lesson
study was implemented in Zambia. Lesson study at Schools A and C was introduced in 2012 and 2014, respectively. School C was a new school, whose construction was completed late 2013. The teachers at both schools were more committed to lesson study than those at School B. For example, all the teachers who planned Lesson 1 and 2 at School A observed the lessons, attended the reflection sessions, observed the re-teaching of the revised lessons, and attended the post lesson discussions. In the case of School B, the teachers who planned Lesson 1 did not observe the lesson, and the lesson was re-taught by a different teacher, who later chaired the post lesson discussion, which was only attended by two pre-service teachers and the Head of Department.

School administrators claimed that collaboration among teachers had improved, and that lesson study had increased teachers’ confidence in teaching and being observed by their colleagues, while the teachers of mathematics also reported many positive effects of lesson study. However, one teacher stated that some teachers had not accepted lesson study, which was confirmed by observations at the schools where at times there was overt antagonism towards lesson study. For example, during planning sessions at School B teachers could not agree when to teach the research lesson, disregarded directives given by the HOD, and did not observe the research lesson. The HOD told the researcher that there was nothing she should do about the situation.

8.3.3 Grade 12 examinations results

Grade 12 national examination results in mathematics before and after the introduction of lesson study were collected at participating schools to examine the performance of students in mathematics. At Schools A and B, data was collected for 2011 and 2014, while at School C data could only be collected for 2015 and 2016.

The investigation of the Grade 12 examination results in mathematics provided no conclusive results. At School A, where lesson study was introduced in 2012, there was a significant decline in student performance between 20011 and 2014, while at School B, where lesson study in mathematics had been introduced in 2008 and where its implementation was the weakest among the schools observed, there was a significant improvement in the results between 20011 and 2014, albeit from a very low base. At School C, where lesson study was introduced in 2015,
there was no change in the 100% pass rate between 2015 and 2016.

Overall, there seems to be a wide discrepancy between the reported positive effects of lesson study and the observational data obtained in this study.

8.4 Support mechanisms and challenges

Unlike Japan, where lesson study is voluntary but has a century-old history, lesson study in Zambia is a top-down initiative, with the Ministry mandating that lesson study should occur once a month in every primary school and once a month in every subject area in every secondary school.

To help teachers meet this demand, the Ministry established a number of support mechanisms.

8.4.1 Professional development frameworks

As discussed in Chapter 5, lesson study was introduced in Zambia through the school-based School Program of In-service for the Term (SPRINT). Lesson study was regarded as a “perfect fit” with SPRINT due to its school-based nature which was seen to result in minimal disturbances to school activities, low cost professional development without the need to employ “trainers”, and its focus on improving teaching and learning in the classroom in which teachers act as agents of change.

Ministry documents, in particular, the Implementation Guidelines, the Teaching Skills Book and the Management Skills Book, were regarded by interview participants as valuable resources for implementing lesson study, although much of the support referred to related to the effect of mandating the implementation of lesson study.

In addition, the Ministry established structures for supporting lesson study at the provincial, district, zone, and school levels. The extensive and detailed programme described in the Implementation Guidelines for the Facilitators’ and Stakeholders’ workshops suggests that the Ministry was committed to ensuring that lesson study succeeded. Stakeholders’ workshops were facilitated and monitored by the Provincial Education Support Team (PEST) and the District Education Support Team (DEST), and were attended by School and zone INSET Coordinators, class teachers, facilitators, and school administrators including Heads of
Department, senior teachers, deputy headteachers and headteachers.

However, as already reported in Chapters 4 and 5, there was some initial resistance to these workshops, especially from teachers who believed they “knew-it-all”, whose participation, in fact, is critical in lesson study and who could become potential lesson study experts within schools. If these qualified teachers, with many years of experience, could be exposed to lesson study and given opportunities to comment on lessons, because of their vast experience in teaching mathematics, they could become future external experts. However, it should be noted that these experienced teachers cannot become external experts at once but can only do so over a period of time, through extended participation in lesson study and training as experts (Takahashi & McDougal, 2016).

8.4.2 In-service providers and school administrators

As well as conducting workshops, some in-service providers who were interviewed said they held meetings at schools and took part in the lesson study cycles. However, their focus appeared to be mainly on monitoring school records relating to the implementation of lesson study, with Ministry headquarters monitoring lesson study using a chain of reports provided in turn by schools, districts and provinces.

School administrators also said that they participated in lesson study, a claim that was disputed by at least one teacher, who regarded this as a serious omission.

8.4.3 Monitoring structures

This study found several levels of monitoring of lesson study in Zambia: Ministry level, district level, zone level, and school level. The Ministry has standardised lesson study monitoring through checklists (MOE & JICA, 2010a) and this helps those monitoring lesson study to extract information, such as the number of cycles completed, the number of people who attended, the topic, and the responses and reactions and observations made.

Some in-service providers regarded monitoring as one of the significant lesson study support mechanisms, with some reporting that they monitored lesson study; participated in lesson study activities; and talked to Head Teachers about the implementation of lesson study during school senior management meetings.
However, school-level monitoring was used as the in-service providers could not afford to be in every school in the district with the limitations of transport and staff. Therefore, head teachers are authorised to monitor lesson study activities using the Heads of Departments and the mechanisms used within schools. The School Inset Co-ordinator is the person directly in charge of all CPDs, including lesson study, in School monitoring.

8.4.4 The new mathematics curriculum

The new curriculum was identified by Ministry Officers and other in-service providers as supporting lesson study by promoting principles that resonated with lesson study and by containing topics that teachers found challenging, which was a criterion for selecting topics for lesson study. According to in-service providers, the Stakeholders’ and Facilitators’ workshops, which were repeated each term, retrained teachers in the new mathematics topics in the revised curriculum, while lesson study assisted in the successful transition to the new curriculum.

It is sometimes claimed that lesson study in Japan is not funded or supported by the government. However, Lewis and Takahashi (2013) describe in detail the four types of lesson study that operate in Japan – School-wide lesson study, District-level lesson study, National school-based lesson study, and Association-sponsored lesson study – and the support they receive through the use of paid work time to conduct planning meetings, as well as small grants provided to designated research schools to study a specific curriculum change and “bring it to life in public research lessons” (p. 211).

Lewis and Takahashi (2013) further describe how these four types of lesson study interact and interlock to produce system-wide, long-term support for curriculum reform, as well as help to shape the nature of the reform, stating that

In all, three features of the Japanese educational landscape provide crucial support for lesson study used to facilitate curriculum implementation: the system of designated research schools, the robust networks that bring together university-based and school-based educators, and the established learning routines at Japanese schools (such as reflection, grade-level collaboration, and teachers’ leadership of school initiatives). (p. 215)
Such deeply embedded, coherent support for lesson study is not something that can be established in a short time.

8.4.5 Infrastructure support

At the District level efforts had been made to allocate funds for lesson study in mathematics, with a budgetary allocation for lesson study in mathematics and for the activities of Standard Officers and the District Resource Centre Coordinators, but allocated funds are not adequate. Further, at Ministry level, the delay in the disbursement of resources affects the timely implementation of lesson study support activities. This problem is compounded by insufficient transportation or money for fares for participants.

Providing sufficient instructional materials in schools has been one of the priorities for the Ministry (MOE, 2003). However, this study shows that teachers were concerned about a lack of adequate instructional materials. As a result, teachers might not be able to investigate a wide range of instructional materials during lesson study. Further, teachers might not select appropriately the task for students for research lesson. As Watanabe, Takahashi and Yoshida (2008, p. 135) point out, the appropriate selection of the hatsumon involves kyozaikenkyu, which involves investigating a large range of instructional materials, including textbooks, curriculum materials, lesson plans and reports from other lesson studies, as well as a study of students’ prior understandings.

According to the school administrators who were interviewed, lesson study was supported through the timetabling of lesson study activities, which were monitored through the provision of written reports. Administrators also said that teachers participating in lesson study were supported with funding, transport, and equipment for making presentations. However financial constraints were raised as a challenge, with one Headteacher stating that funding was inadequate, while another Headteacher was concerned that teachers who did not understand lesson study were focussing on physical benefits, such as the refreshments some schools provided during lesson study. She said that some teachers did not want to participate in the lesson study sessions if the school did not provide refreshments.

Nevertheless, an indication of the level of infrastructure available can be inferred from the following quote from one of the in-service providers:
Because it is timetabled … it is included in the budget, to say. During that day, at least there will be refreshments and any other logistical support. Paper will be available, the forms which will be used by observers will be able to be printed.

8.4.6 Challenges

A wide range of challenges in implementing lesson study were anticipated in the Implementation Guidelines. These included: low commitment by school management to professional development of teachers; inadequate time; geographical location of schools; negative attitudes among some teachers; insufficient skills of teachers; inadequate materials; and the limited number of qualified teachers of science and mathematics in schools.

Among the challenges identified by interviewees was a lack of adequate funding and funds not being available at the times when they were needed. Finances were also insufficient to secure adequate materials that schools needed to implement lesson study. Some schools depend entirely on students’ school fees to pay for extra-curricular events. This shortage of finance is a severe handicap for attendees at lesson study, as other Ministry CPD events offer free lunches, a strong inducement to attend.

Despite the information in the Teaching Skills Book and Implementation Guidelines on the importance of lesson study to teacher professional growth and student learning, some teachers are not interested in lesson study. Some think they have enough content knowledge and skills that they acquired during their university programmes. Others have students getting very good grades in mathematics, and such teachers may consider lesson study a waste of time, partly because in many schools in Zambia lesson study is seen as an instrument for producing high scores in examinations. Thus, teachers who produce high scores do not see the need to participate in lesson study.

Other challenges identified included the lack of a sufficient number of officers to monitor lesson study in all schools, as well as the fact that schools rarely invited Ministry Officers to help them with lesson study.

Ministry officers, too, have challenges conducting site verification inspections of lesson study activities. Dependence on reports from schools may not reveal the reality, whereas actual observation of lesson study would enable officers...
to see what is done well, and what is not.

8.5 Conclusion

The introduction of lesson study in Zambia took place at a time when there was a huge increase in student numbers and a shortage of qualified teachers of mathematics and science. JICA provided the external expertise to assist in the introduction of lesson study in Zambia, with high-level officers from the Ministry of Education visiting Japan and other countries, such as Malaysia and Kenya, to learn about lesson study.

The Ministry established two KK (kyozaikenkyu) teams, one in mathematics and one in science, with JICA support. After attending the training in Japan and in Zambia, the KK team members have worked continuously as core technical personnel for extending lesson study to schools and the improvement of mathematics and science lessons and lesson study.

While the Zambian model of lesson study as defined in the Ministry’s key publications attempts to be as authentic as possible when compared with Japanese Lesson Study, there are some critical differences in terms of the duration of a research cycle, the lack of emphasis on adopting a problem solving approach, the absence of concluding remarks from an outside knowledgeably other, and the requirement to re-teach the research lesson to a different class.

This study suggests that fidelity to the Zambian model of lesson study becomes less and less the more you move into the centre of the Onion Rings, with the observations and interviews suggesting that many school administrators and teachers lack sufficient understanding of lesson study and have very little time to conduct lesson study due to various other commitments.

Moreover, the frequency of lesson study cycles means that deep kyozaikenkyu is almost impossible to achieve; and that even with a desire to include outside experts (knowledgeable others) at research lessons and post-lesson discussions it would be extremely difficult to do this with so many lesson study cycles happening at each school and so few people currently having the knowledge or experience to act as a knowledgeable other.

To this end, teachers spending very little time on lesson study is a major constraint to a high-fidelity implementation of Zambian lesson study defined by the
Ministry. This is possibly the most urgent aspect to remedy in the short-term as spending sufficient time on lesson study is a relatively known aspect in and outside Japan. In Zambia, traditional teacher-centred lessons have also persisted because teachers feel obliged to transmit information to students so that they pass the national examinations. However, since lesson study is in its infancy in some schools in Zambia, its significant effect on student achievement might not yet be observable.

Given the tremendous challenges being addressed, it is unsurprising that by the time we reach the centre of the Onion Rings – implementation of lesson study at school level – the degree of fidelity to the Zambian model is relatively low.

8.6 Significance of the study

This study contributes to the body of scholarly knowledge by adding to the literature on lesson study implementation, in countries other than Japan, and by applying the Onion Rings Model to help extend the theoretical understanding of the implementation of lesson study.

8.6.1 Contribution to the literature on lesson study implementation

This study contributes to the literature on the implementation of lesson study in countries other than Japan lesson study by investigating the implementation of lesson study in an under-resourced developing country where lesson study has been mandated for all subjects across all schools nationwide. Specifically, there is limited understanding of how lesson study is defined by the education policy and how insufficient levels of support for teachers results in them being unaware of the critical features of lesson study.

Furthermore, Chapter 2 emphasised the need to extend our understanding of the school-level implementation of lesson study in mathematics in secondary schools. A deep understanding of how lesson study is defined by its adaptors, such as Zambia, could enable us to speculate the extent to which those who implement lesson study appreciate critical features of lesson study.

This study has shown that some in-service providers and school administrators, who participated in the study, had knowledge about the critical
features of lesson study, because they had participated in lesson study in Japan, while teachers exhibited limited knowledge. It seems that first-hand experience could not be transferred easily to teachers in Zambia who had not had Japanese experience. Further research into how a broader understanding within the education community could assist in the implementation as desired by the Ministry, is clearly needed, and this study has illuminated some aspects of the Zambian situation that may assist this research. For example, the case studies show that the time needed for planning and observing research lessons, is not available due to the broader educational context in Zambia.

This study has exposed many challenges affecting the optimal functioning of the lesson study support structures. First, teachers usually have little time for lesson study because of the heavy work load. For example, the teachers at two of the schools taught in both the morning and afternoon classes (referred to as APU classes). They could not find time to conduct lesson study outside classes and students were left unattended when teachers were conducting lesson study. The other school, which did not have APU classes and which was a boarding school, tried to solve this problem by conducting lesson study activities in afternoon when students were on prep.

This study has extended the understanding of the implementation of lesson study at school level in Zambia. Detailed analysis of the video-data of the lesson study cycles at the three case study schools, using Transana, revealed challenges faced in implementing lesson study. These included planning sessions conducted without a draft lesson plan for discussion, using very few books during planning the lesson, and not inviting an external expert to make comments. The few books referred to the student text books the teachers used for student tasks. It seems the little time teachers spent planning the research lessons and reflecting on the lessons could allow them to search a wide range of books, including the New Mathematics Syllabus. The school administrators, who were supposed to comment on research lessons, in the absence of knowledgeable other, were committed to other pressing issues in their schools and outside their schools, including attending workshops for lesson study. Besides, the role of school administrators was to monitor lesson study instead of supporting it.

Furthermore, the research lessons did not exhibit the features of the structured problem-solving lessons typically used in Japanese Lesson Study in
mathematics, with lessons being teacher-centred rather than student-centred, and other elements being omitted. Lesson observation focussed on the teacher and not on student learning, as observers in this study did not focus on, or record, students’ strategies. In addition, in two research lessons, it seemed natural that observers could interject during the lesson. These findings merit attention as they have implications for the successful implementation of lesson study elsewhere. For example, if there is no focus on student thinking, the possibility of transforming teacher-centred lessons into student-centred lessons is exceedingly low.

Seleznyov (2018) suggested that there is not an internationally shared understanding of Japanese Lesson Study and that translation can result in quite significant changes to lesson study processes. However, this study suggests that successful implementation of school-based lesson study in mathematics, outside Japan, among other things requires a shared research theme across the school, the participation of an external expert, a focus on student thinking, the skilful use of various instructional materials, designing detailed lesson plans, and using structured problem-solving lessons.

**8.6.2 Applying the Onion Rings Model to lesson study implementation**

This study used the Onion Rings Model to deepen understanding of lesson study in contexts where lesson study is not a voluntary activity in schools, but a directive from the government.

In this study, the first (outer) ring denotes the lesson study model defined by the Ministry for use in Zambian schools. The study has found that the Zambian lesson study model was in many ways similar to Japanese Lesson Study, except for aspects such as the 8-step cycle, which includes reteaching of revised lesson, and the prescribed duration of a lesson study cycle as no more than five days.

The second ring refers to the perspectives of the in-service providers of lesson study, and the roles they play in promoting the implementation of lesson study. This study shows that the in-service providers play a pivotal role in ensuring that lesson study is implemented nation-wide according to the policy. They also monitor lesson study activities using check-lists.

The third ring denotes the school environment, focussing on both the school culture and the classroom environment. This study has shown that lesson
study has started reforming teacher collaboration and staff relationships. For example, all the teachers who were interviewed in this study said that collaborative research lesson planning should be supported by allocating time in the school timetable. This suggests that lesson study is helping to create conducive environments in Zambian schools for professional development, albeit under pressure from lack of time.

The classroom environment comprises the physical and pedagogical aspects of the classroom, including instructional materials. With respect to the pedagogical aspects of the classroom environment, this study has shown that mathematics research lessons do not necessarily follow the structured problem-solving approach typically used in Japanese Lesson Study in mathematics.

The fourth ring represents teachers of mathematics, focussing on their views on lesson study, and their personal characteristics – competencies, beliefs and attitudes. This study has shown that teachers’ characteristics have started changing as they participate in lesson study. However, the findings suggest, also, that non-participation of external experts in lesson study could hamper meaningful participation of teachers in lesson study, as external experts usually help teachers deepen their content and pedagogical knowledge (Takahashi, 2014).

Finally, the central ring denotes the actual activities during the lesson study cycle – planning, teaching and observing the lesson, post-lesson discussions, and other follow-up activities such as the reteaching of the revised lesson. As pointed out Chapter 3, the Onion Rings Model discourages the treatment of the units of analysis (for example, the school environment) as independent of one another. Therefore, the use of the Onion Rings Model in this research has increased the chances of making better inferences from the findings, thereby providing more reliable answers to the research questions.

In particular, the use of the Onion Rings Model in this study has deepened the understanding of the decrease in fidelity to the model in contexts where lesson study is not a voluntary activity in schools. This weakening may be seen in the gaps in understanding, of the elements of lesson study, between Ministry of Education personnel at different levels of the model. We can, for example, conclude that the there was no strong link between Ring 1 (Ministry of Education) and Ring 2 (In-service providers) in term of providing the resources required by In-service providers to support lesson study. This is a serious omission when effective
implementation is required. Omissions, such as this, identify flaws in the Ministry approach to implementation, suggesting that a more considered approach needs to be used.

8.7 Implications for policy and practice

The findings of this study have highlighted several factors that have hampered the successful implementation of lesson study in mathematics in Zambia. The main implications for practice from these findings are presented below.

8.7.1 Understanding of lesson study

The demand by the Ministry that a lesson study cycle be completed within five days and that each school should complete one lesson study cycle each month in every subject makes it logistically impossible to implement an authentic version of Japanese Lesson Study. Firstly, it is impossible to undertake deep kyozaikenkyu given the time constraints imposed, making for a hastily prepared lesson plan which is unlikely to lead to informed discussion and teacher learning. Secondly, the frequency and timing of the lesson study cycles, as well as the current scarcity of suitably experienced people, makes it impossible to ensure that external experts attend and give comments on the research lessons.

This study has shown that lack of contact between teachers and those trained in lesson study (such as the school administrators and in-service providers) reduces the opportunities for developing a deeper understanding of lesson study and maximising the benefits from lesson study. Those trained in lesson study can help teachers overcome some of the difficulties they face in implementing lesson study, correct some of their misconceptions, and bring a broader perspective to the whole process. The Ministry should consider increasing contact between teachers and those trained in lesson study.

8.7.2 Lesson study support mechanisms

The study has found that there are many challenges in a country where lesson study has been mandated and an attempt has been made to roll it out systemically. It is evident in this study that while lesson study in Zambia might be systemic, it is “top-down” and so not sufficiently owned or valued at various levels
of the system. In many other countries, lesson study is not part of the system and the opposite problem is encountered – of initiating this kind of teacher professional development in schools, and then expanding the reach of what inevitably are initially relatively small-scale projects (Lewis, 2002).

The interview and observation data suggest that although the Ministry has established the Education Support Teams at national, provincial, district and school levels, these teams are non-functional because of the many challenges in the system. The suggestion by the in-service providers that increasing budgetary allocation for CPD activities and providing the school with adequate instructional materials would help improve the implementation of lesson study in schools seems insufficient. The Ministry should pay attention to addressing the challenges the system is facing, such as lack of time by teachers to implement lesson study. For example, the Ministry can improve staffing levels so that teachers’ workloads are reduced thereby creating more time for lesson study. This could work well in schools without APU classes. Another option could be to decrease the amount of content in the syllabus to create enough time for lesson study, moving towards a more Japanese style frugal mathematics curriculum that supports lesson study (Lewis & Tsuchida, 1998).

It is evident in this study that while some people have been trained in lesson study through visits to Japan and by JICA staff to Zambia, the cascade model of dissemination has not been successful in extending understandings across the rings. An effect or consequence of this is that the in-service providers and Headteachers have become monitors rather than supporters of lesson study. The Ministry should consider exploring the kind of support that is possible over time as the system develops.

Furthermore, the suggestion by some scholars (for example, Takahashi, 2014) that practising teachers themselves could perform the role of knowledgeable others requires a long-term commitment and exposure to lesson study, which seems to offer few short-term opportunities for Zambia because of the current challenges in its system. For example, it takes time to learn how to develop and support worthwhile lesson plans. The Ministry should consider what kind of implementation in Zambia could support the development of such.
8.7.3 Implementation of lesson study at school level

The observed research lessons reported in this study lacked some of the critical features of lesson study – such as participation of an external expert and the investigation of a wide range of instructional materials – as discussed in the literature (e.g., Doig & Groves, 2011; Fujii, 2014; Lewis, 2004; Lewis et al., 2005; Murata, 2011; Takahashi, 2009). This study showed, however, the need for policymakers and school administrators to ensure that lesson study teams are aware of, and implement, the features that make lesson study most effective.

It is evident from the study that school administrators should ensure that lesson study teams have access to adequate materials so that they are able to investigate a wide range of instructional materials and ideas.

The role of observers in research lessons also needs addressing. During each observed research lesson in this study, teacher observers remained seated, gazing at the teacher as the lesson unfolded. Observers should have engaged in observing and recording student strategies. The evidence indicates that observers focussed on the teacher and not the learning. Observers might have shifted their focus if they had studied the lesson plan before observing the lesson, but they never had the opportunity to do so.

In summary, the Ministry should examine the existing challenges in the system and consider the ways of addressing these.

8.8 Limitations

The first limitation of this study is that the extensive and complex phenomenon of “nation-wide implementation of lesson study in mathematics” has been studied using a small number of research settings and participants, which naturally suggests limitations to generalising its results. Similarly, the findings and the conclusions drawn from this study, are context-bound, and therefore it is not possible to make general claims, but only focus on those features of the Zambian context, which hindered, or promoted, the implementation of lesson study in mathematics: these may well be different in other contexts.

A further limitation of this study is the focus of the study on particular categories of participants. Understanding other perspectives, such as the
perspectives of the Japanese nationals helping Zambia to implement lesson study, in addition to perspectives by Baba and Nakai (2011), could well have been fruitful. Japanese nationals under the Japan Overseas Cooperation Volunteers have been helping teachers in selected schools to implement lesson study. Hence, their perspectives could deepen our understanding of lesson study in Zambia.

While this study adopted the Onion Rings Model from the European Commission (2011), it is argued that the Onion Rings Model is a good point of reference for analysing the implementation of lesson study in mathematics in Zambia, where the government directs, through policies, what is to be done, and thus the effective implementation of lesson study was a function of the national policy, mediated by in-service providers, school culture and classroom environments, and teachers’ personal characteristics. Taking this into consideration, and that there are few studies that proposed frameworks for analysing a nation-wide implementation of a fundamental pedagogical change, at both macro- and micro-levels, this study is limited to a lesser extent than other similar studies.

8.9 Implications for further research

This study has revealed pertinent issues surrounding the implementation of lesson study in mathematics, taking Zambia as a case study. As this policy is still being implemented, considerable work remains to be done in the quest for a comprehensive understanding of how lesson study in mathematics is being implemented in countries where government has mandated lesson study. Future research should extend this study by using more secondary schools within a nation as case study sites. Whereas the participants in this study were the Ministry of Education personnel, future research could extend the participants to include the Japanese Lesson Study experts managing JICA-sponsored lesson study projects, and the producers of curriculum and other instructional materials.

Furthermore, the validity of the Onions Rings Model to present and explain findings needs to be applied in different situations, with other models to triangulate and thus verify the results, and also helping to understand the complex relationships, between different levels of responsibility, in a wider range of studies, and further clarify the applications for the Onion Rings Model.
A significant research challenge is to investigate how best to use the knowledge gained from this study.
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Appendices

Appendix 1: Interview schedule for in-service providers

IMPLEMENTATION OF LESSON STUDY IN MATHEMATICS: 
THE CASE OF ZAMBIA

INTERVIEW SCHEDULE 1

(In-service providers)

PART 1: IDENTIFYING INFORMATION
Interview with (Name), Officer at (Name of Department/School District), (date)
conducted by (interviewer)

PART 2: INTRODUCTION AND BACKGROUND INFORMATION
Thank you for agreeing to this interview

2.1. What is your current position?
2.2. How long have you served in this position?

2.3. In this Department/District?
2.4. In another Department/District?

2.5. What role does your department/district play in the provision of
teacher continuing professional development (CPD)?
2.6. What exact role do you play in the CPD programmes?
2.7. In what types of CPD programmes do teachers in your district(s)
participate?

2.8. How often?
2.9. In mathematics?

2.10. Which CPD approaches do you find most useful?
2.11. Is there anything else you would like to add about your role in the
provision of CPD?
PART 3: DEFINITION OF LESSON STUDY IN ZAMBIA

3.1. What do you understand about Lesson Study as a CPD approach?
3.2. Where did you get this information?
3.3. What do mathematics teachers learn by participating in lesson study?
3.4. Do you have any concerns over teachers’ participating in lesson study?
3.5. In what ways, if any, lesson study is different from other CPD approaches (e.g. cascade method)?
3.6. Is there anything else you would like to add about lesson study in Zambia?

PART 4: LESSON STUDY SUPPORT MECHANISMS

4.1. Please describe the typical mechanisms your department/school district have implemented or intend to implement to support lesson study in schools.
4.2. Are there standards you have set for school district(s) on lesson study?
4.3. Do you have a policy on CPD?
4.4. On lesson study in mathematics?
4.5. To what extent do you usually end up following your policy?
4.6. Is there a budgetary allocation for CPD in mathematics?
4.7. For lesson study in mathematics?
4.8. What monitoring mechanisms have you put in place?
4.9. How do you use the findings from monitoring in planning the supporting mechanisms?
4.10. To what extent does the MOE 2014 revised school curriculum support lesson study?
4.11. What could have department/school district done differently to support lesson study in mathematics?
4.12. What challenges do you face in supporting lesson study?
4.13. Is there anything else you would like to add about lesson study support mechanisms?

PART 5: IMPLEMENTATION OF LESSON STUDY IN MATHEMATICS IN SCHOOLS

5.1. How do you allocate authority for setting the goals for lesson study at each school and designing strategies to meet such standards between your department/school district and each school?
5.2. Is the authority for setting of the goals for lesson study and designing strategies to meet the goals contractible?
5.3. What structures exist at school level to support lesson study?
5.4. To what extent are schools complying with the directive from the Ministry that one lesson study cycle should be implemented every month?
5.5. Do schools follow the 8-steps the Ministry has prescribed for lesson study?
5.6. If not, why?
5.7. What are some of the challenges schools have in implementing lesson study in mathematics?
5.8. Is there anything else you would like to add about the implementation of lesson study in schools?

PART 6: EFFECTS OF LESSON STUDY

6.1. Please describe what the effects of lesson study have been on your departmental/school district goals, principals, teachers and student performance in mathematics.
6.2. Do you record or quantify the effects of lesson study? Yes/no. If yes, how?
6.3. On meeting your departmental/school district goals?
6.4. Mathematics teachers?
6.5. Student performance?
6.6. Can you give me an example of the effects of lesson study on teachers?
6.7. Student performance?
6.8. Departmental/school district goals?
6.9. What do you consider as some of the challenges in quantifying the effects of lesson study?
6.10. Is there anything else you would like to add about the effects of lesson study?

THANK YOU
Appendix 2: Interview schedule for school administrators

IMPLEMENTATION OF LESSON STUDY IN MATHEMATICS:
THE CASE OF ZAMBIA

INTERVIEW SCHEDULE 2

(HEADMASTER AND SCHOOL CO-ORDINATOR OF CPD)

PART 1: IDENTIFYING INFORMATION

Interview with (Name), administrator at (Name of participating school), in (Name of school district), (date) conducted by (interviewer).

PART 2: INTRODUCTION AND BACKGROUND INFORMATION

Thank you for agreeing to this interview

2.1. What is your current position?
2.2. How long have you served in this position?
2.3. In this school?
2.4. In another school?
2.5. What role does your school/mathematics department play in the provision of teacher continuing professional development (CPD)?
2.6. What role do you play in CPD programmes?
2.7. In what types of CPD programmes do teachers in this school or mathematics department participate?
2.8. How often?
2.9. In mathematics?
2.10. How often?
2.11. Which CPD approaches (formats) do you find most useful?
2.12. Is there anything else you would like to add about your role in the provision of CPD at this school/mathematics department?

PART 3: DEFINITION OF LESSON STUDY IN ZAMBIA

3.1. What do you understand about lesson study as a CPD approach?
3.2. Where did you get this information?
3.3. What do mathematics teachers learn by participating in lesson study?
3.4. Do you have any concerns with teachers’ participating in lesson study?
3.5. In what ways, if any, is lesson study different from other CPD approaches (e.g. the cascade approach)?
3.6. Is there anything else you would like to add about your definition of lesson study in Zambia?

PART 4: LESSON STUDY SUPPORT MECHANISMS

4.1. Please describe the typical strategies your school/mathematics department have implemented or intend to implement to support lesson study at this school.
4.2. Are there short-term or long-term goals you have set for lesson study?
4.3. Do you have a stand-alone school policy on lesson study in mathematics?
4.4. To what extent do you usually end up following your policy?
4.5. To what extent is lesson study important in school planning. How is this shown? (e.g. in time-tableing)?
4.6. Is there a school budgetary allocation for CPD? If Yes, how much?
4.7. Is there a school budgetary allocation for lesson study in mathematics? If yes, how much?
4.8. What monitoring structures are in place to ensure lesson study is implemented?
4.9. How do you use the findings from monitoring in planning?
4.10. In what ways, if any, do you support teachers from your school participating in lesson study at other schools in the district?
4.11. What could your school/mathematics department do different to support lesson study?
4.12. What challenges do you face in supporting lesson study?
4.13. Is there anything else you would like to add about lesson study support mechanisms?

PART 5: IMPLEMENTATION OF LESSON STUDY IN MATHEMATICS IN SCHOOLS

5.1. How do you allocate authority for setting goals (i.e. short-term and long-term goals) for lesson study and designing strategies to meet such goals between you, school administrators, and the teachers?
5.2. Is the authority for setting of goals and designing strategies to meet these goals contractible?
5.3. To what extent is your school complying with the directive from the Ministry that one lesson study cycle should be implemented every month?
5.4. Does your school follow the 8-steps the Ministry have prescribed for lesson study?
5.5. If no, why?
5.6.  Your role in the following:
   5.6.1. Defining a problem and challenge.
   5.6.2. Planning the research lesson.
   5.6.3. Implementing the research lesson.
   5.6.4. Discussing the research lesson and reflecting on its effects.
   5.6.5. Revising the lesson.
   5.6.6. Teaching the revised lesson.
   5.6.7. Discussing the research lesson and reflecting again.
   5.6.8. Compiling and sharing reflections.

5.7. Do you invite external experts to participate in lesson study?
5.8. If you do, which institutions are these experts drawn from?
5.9. In which of the 8-steps of lesson study cycle do the experts participate?
5.10. What exact role do these experts play?
   5.11. What are some of the challenges your school is facing in implementing lesson study in mathematics?
   5.12. Is there anything else you would like to add about the implementation of lesson study at your school?

PART 6: EFFECTS OF LESSON STUDY

6.1. Please describe what the effects of lesson study have been on your school/mathematics department, teachers and students.
6.2. Do you record (or quantify) the effects of lesson study. If no, why? If yes, how?
   6.2.1. The school goals?
   6.2.2. Goals of mathematics department?
   6.2.3. Mathematics teachers?
   6.2.4. Student performance?
6.3. What do you consider as some of the challenges in quantifying the effects of lesson study?
6.4. Is there anything else you would like to add about the effects of lesson study?

THANK YOU
Appendix 3: Interview schedule for teachers of Mathematics

IMPLEMENTATION OF LESSON STUDY IN MATHEMATICS: THE CASE OF ZAMBIA

INTERVIEW SCHEDULE 3

(TEACHERS PARTICIPATING IN LESSON STUDY)

PART 1: IDENTIFYING INFORMATION

Interview with (Name), Grade (Year Level) Teacher at (Name of School), (date) conducted by (interviewer)

PART 2: INTRODUCTION AND BACKGROUND INFORMATION

Thank you for agreeing to this interview.
2.1 What is your current position?
2.2 How long have you been a mathematics teacher in secondary schools?
   2.2.1 At this school?

PART 3: PARTICIPATION IN CONTINUING PROFESSIONAL DEVELOPMENT (CPD) PROGRAMMES

3.1 What types of CPD programmes have you participated in during the past four years in mathematics? How often?
3.2 Which CPD approaches do you find the most useful?
3.3 Is there anything else you would like to add about your previous participation in CPD programmes?

PART 4: DEFINITION OF LESSON STUDY

4.1 What do you understand about lesson study as a CPD approach?
4.2 Where did you get this information?
4.5 How does lesson study compare with your previous experiences of professional learning?
4.5.1 Similarities? Differences?
4.5.2 Strengths? Weaknesses?

PART 5: SUPPORT MECHANISMS

5.1 What do you consider as critical elements in school culture that are needed to support lesson study?
5.2 To what extent have these been present in this school?
5.3 To what extent has lesson study been supported by
   5.3.1 Mathematics curriculum?
   5.3.2 School leadership style?
   5.3.3 Staff relationships and communication?
5.4 What do you consider as critical elements in the classroom environment that are needed to support lesson study? To what extent have these been present since the introduction of lesson study?
5.6 What support would be required to expand lesson study in your school?
5.7 Is there anything else you would like to add about the mechanisms needed to support lesson study implementation?

PART 6: HOW LESSON STUDY IS BEING IMPLEMENTED AT THE SCHOOL

Lesson planning

6.1. What materials do you use for planning the research lesson?
6.2. How have you benefited from lesson study, and what challenges have you faced?
6.3. What changes (if any) have you made or intend to make in your planning as a result of your participation in research lessons (lesson study)?
6.4. What additional resources or support do you need to make these changes?

Implementing the research lessons (teaching and observing research lessons)
6.5. What previous experience did you have of people observing your lessons (other than as a pre-service teacher)?

6.6. What do you learn from teaching a research lesson?

6.7. Why did you react the way you did?

6.8. If we could reverse the situation, would you reaction be different? Why?

6.9. What other challenging situations (if any) have you encountered in teaching research lessons, and how have you resolved them or plan to resolve them?

6.10. What do you say about re-teaching a revised lesson by the same teacher who taught the initial research lesson?

6.11. What challenges have you faced (if any) from re-teaching the research lesson?

6.12. What are the main things have you learnt from re-teaching a revised lesson?

6.13. What are the benefits and challenges of observing a research lesson?

6.14. What aspects of teaching and observing research lessons could be incorporated into your class practice?

6.15. Is there anything else you would like to add about the teaching and observation of the research lesson?

Discussing the lesson and reflecting on its effects

6.16. What have you benefited from the participation of external experts in discussing the lesson and reflecting on its effects?

PART 7: EFFECTS OF LESSON STUDY

Use of problem solving approach to teach mathematics

7.1 What have been some of the challenges for using problem solving to teach content?

7.2 What changes have you made or intent to make regarding the use of problem solving in your mathematics lessons?

7.3 What support would you need to achieve your goals relating to problem solving?
Discussion of student strategies and solutions

7.4 To what extent is extensive discussion of student strategies and solutions incorporated into the research lessons planned by your team?

7.5 What are the benefits and challenges with this approach?

7.6 What changes (if any) have you made or intend to make regarding the use of this approach?

Student performance on Grade 9 examinations

7.16 Please explain whether lesson study has had any effect on student performance on Grade 9 examinations.

School culture

What changes (if any) have you noticed from the time lesson study was introduced at this school in

7.17 School leadership style?

7.18 Teacher collaboration?

7.19 Staff relationships and communication?

Teacher attitudes towards mathematics

7.20 Describe how your views about mathematics have changed as result of your participation in lesson study?

THANK YOU