TEACHER PROFESSIONAL GROWTH:
A STUDY OF PRIMARY TEACHERS INVOLVED IN
MATHEMATICS PROFESSIONAL DEVELOPMENT

Hilary Hollingsworth
B. Ed. (Prim.), Dip. T. (Prim.)

Submitted in fulfilment of the requirements of the Degree of
Doctor of Philosophy in the Faculty of Education, Deakin University.

February, 1999
I am the author of the thesis entitled *Teacher Professional Growth: A Study of Primary Teachers Involved in Mathematics Professional Development* submitted for the degree of Doctor of Philosophy.

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Full Name

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7 July 1999
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I certify that the thesis entitled *Teacher Professional Growth: A Study of Primary Teachers Involved in Mathematics Professional Development* submitted for the degree of *Doctor of Philosophy* is the result of my own research, except where otherwise acknowledged, and that this thesis in whole or in part has not been submitted for an award, including a higher degree, to any other university or institution.

Full Name: Hilary Faith Hollingsworth

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Date: 7th July 1999
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<td>Vignette of Lesson Observed: Anne (Source: Observation 2)</td>
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<td>7.3</td>
<td>Vignette of Lesson Observed: Anne (Source: Observation 3)</td>
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<td>Vignette of Lesson Observed: Anne (Source: Observation 4)</td>
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<td>Vignette of Lesson Observed: Anne (Source: Observation 5)</td>
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<td>7.6</td>
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<td>7.7</td>
<td>Vignette of Lesson Observed: Anne (Source: Observation 7)</td>
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<td>7.8</td>
<td>Vignette of Lesson Observed: Anne (Source: Observation 8)</td>
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<td>7.9</td>
<td>Vignette of Lesson Observed: Beth (Source: Observation 1)</td>
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<td>7.10</td>
<td>Vignette of Lesson Observed: Beth (Source: Observation 2)</td>
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<td>Vignette of Lesson Observed: Beth (Source: Observation 3)</td>
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<td>7.12</td>
<td>Vignette of Lesson Observed: Beth (Source: Observation 4)</td>
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<td>7.13</td>
<td>Vignette of Lesson Observed: Beth (Source: Observation 5)</td>
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<td>Vignette of Lesson Observed: Beth (Source: Observation 6)</td>
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<td>Vignette of Lesson Observed: Beth (Source: Observation 7)</td>
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<td>Vignette 7.16</td>
<td>Vignette of Lesson Observed: Beth (Source: Observation 8)</td>
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<td>Vignette 7.17</td>
<td>Vignette of Lesson Observed: Brian (Source: Observation 1)</td>
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<td>Vignette 7.18</td>
<td>Vignette of Lesson Observed: Brian (Source: Observation 2)</td>
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<td>Vignette of Lesson Observed: Brian (Source: Observation 3)</td>
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<td>Vignette of Lesson Observed: Brian (Source: Observation 4)</td>
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<td>Vignette of Lesson Observed: Cath (Source: Observation 2)</td>
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<td>Vignette 7.26</td>
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<td>Vignette of Lesson Observed: Cath (Source: Observation 7)</td>
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<td>Vignette 7.29</td>
<td>Vignette of Lesson Observed: Debra (Source: Observation 1)</td>
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<td>Vignette 7.30</td>
<td>Vignette of Lesson Observed: Debra (Source: Observation 2)</td>
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<td>Vignette 7.31</td>
<td>Vignette of Lesson Observed: Debra (Source: Observation 3)</td>
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<td>Vignette 7.32</td>
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<td>Vignette 7.33</td>
<td>Vignette of Lesson Observed: Debra (Source: Observation 5)</td>
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<td>Vignette 7.34</td>
<td>Vignette of Lesson Observed: Debra (Source: Observation 6)</td>
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<td>Vignette 7.35</td>
<td>Vignette of Lesson Observed: Debra (Source: Observation 7)</td>
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<tr>
<td>Vignette 7.36</td>
<td>Vignette of Lesson Observed: Debra (Source: Observation 8)</td>
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</table>
The overall purpose of this study was to examine whether professional development programs can act as appropriate vehicles for the professional growth of teachers of primary mathematics.

A longitudinal study was conducted of primary teachers involved in a Victorian mathematics professional development program—Exploring Mathematics In Classrooms (EMIC). The professional growth of six teacher participants in one EMIC course was examined over a period of 18 months. The teachers selected were from four different schools located in the southern metropolitan region of Melbourne.

The central interest of this study was in teacher professional growth and accordingly the perspective sought was predominantly that of the teacher. A case study research approach was adopted and data were gathered through observations, interviews, questionnaire, and the collection of teacher work documents. A theoretical model of teacher professional growth was used to represent the teachers’ growth.

The study generated data on the nature of teacher professional growth and the features of professional development programs likely to influence teacher professional growth.

All of the teachers reported and demonstrated growth with respect to their mathematics teaching, in areas associated with their: Classroom Practice, Knowledge and Beliefs, and Professional Attributes. The teachers’ growth was highly individualistic, with no two teachers demonstrating exactly the same professional growth outcomes, or the same growth processes. The data provided evidence to confirm that teacher growth is a complex and gradual learning process. For each of the teachers several different routes to change and growth were evident, drawing attention to the non-linear nature of growth. The teachers’ responses to the professional development program were influenced by various contextual and personal factors.

The data provided evidence of a strong link between the content and outcomes of professional development programs—the outcomes reported and demonstrated by the teachers reflected the content of the EMIC program.

Key factors associated with mathematics professional development programs perceived as influencing growth were: program content; program structure; and program presentation. A significant finding was the strong influence on teacher growth
of the presenters of professional development programs—some data suggested that the “quality” of the program presenter is fundamental to the success of any professional development program.

The study provided insight into the processes involved in teacher professional growth and factors associated with the way in which professional development programs influence growth. The theoretical model of teacher professional growth used in this study has been elaborated and recommendations which might inform the design and implementation of future professional development programs have been made.
ACKNOWLEDGEMENTS

The completion of this study was made possible with the support and encouragement of a number of people.

First, my sincere thanks are extended to my supervisors, Associate Professor Susie Groves and Dr David Symington. Their rich expertise, their capacity to support and encourage, and their commitment to this research, has been greatly appreciated.

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I gratefully acknowledge the teachers who gave generously of their time to participate in this study.

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Finally I thank my family and friends for their significant contributions across the time of this study. Special thanks to Fran, Jack, Barry, Helen, Rebecca, Jessica, Sarah, David, Barb, Rainer, Tim, Tristan, Scotty, Andree, Frances, Sandra, Robyn, Mike and Leon.
Chapter 1
Focus of the study

1.1 Mathematics education, teacher professional growth and professional development—A background

During the period from the early 1980s to the mid 1990s there were widespread calls for changes in the teaching and learning of mathematics (see, for example, Australian Education Council, 1991; Cockcroft, 1982; National Council of Teachers of Mathematics, 1989; National Research Council, 1989). Three forces that shaped these calls for reform were: changing conceptions of mathematics curriculum content; the influence of developing technology; and changing views of learning.

In contrast to many previous reform attempts—which assumed that change would occur through the publication of curriculum documents and texts—it was proposed at this time that changes in mathematics education need to be realised through the agency of teachers (see, for example, Guskey & Huberman, 1995; National Council of Teachers of Mathematics, 1991a; National Research Council, 1989; Shaw & Jakubowski, 1991).

With teachers being given greater responsibility for effecting change in mathematics education, there was increased interest in teacher change, and consequently in teacher professional development. In particular, it was assumed that professional development programs could provide opportunities to effect teacher growth, so that teachers would improve the teaching and learning of mathematics.

A significant outcome of recent research into teacher change and professional development has been the recognition that change is a complex process that involves learning (see, for example, Fullan & Stiegelbauer, 1991; Guskey, 1985, 1986; Hall & Loucks, 1977; Johnson, 1989, 1993, 1996a, 1996b; Teacher Professional Growth Consortium, 1994).

While much has been learnt about teacher change and about the characteristics of effective professional development programs (see, for example, D.M. Clarke, 1994; Cooney, 1994), it is apparent from the research literature that little is known about the actual linkages between participation in professional development programs and professional growth. There is a need for longitudinal studies which could lead to
understanding the processes associated with teacher change, and the features of professional development programs that influence teacher professional growth (see, for example, Sparks & Loucks-Horsley, 1990). In particular, few studies have been conducted of the professional growth of teachers of primary\(^1\) mathematics in the context of organised professional development programs.

These research needs, apparent from the literature, provided specific direction for developing the focus of this study—specifically, this study sought to examine whether professional development programs can act as appropriate vehicles for effecting the professional growth of teachers of primary mathematics.

### 1.2 A personal perspective on researching the professional growth of teachers of primary mathematics

This study of the professional growth of teachers of primary mathematics was influenced by three interrelated factors. These were:

- my interest in teacher change which initially developed through my work as a mathematics curriculum consultant, and later as a lecturer in mathematics education;
- my recognition of the need for research related to teacher change resulting from primary teachers’ participation in mathematics professional development; and
- the personal perspective on teacher change that I developed as a result of my experience and my knowledge of the literature.

When this study commenced I was working as a mathematics curriculum consultant for the Victorian Ministry of Education. My strong interest in teacher change was directly associated with my work—in particular, the impetus for this study came from my desire to better understand the processes associated with change in order to be able to work more effectively with the teachers in my district.

A number of professional development initiatives related to mathematics teaching and learning were developed in Victoria during the mid 1980s. As a mathematics curriculum consultant I had the opportunity to be involved in many of these initiatives.

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1. In the State of Victoria primary school takes in the grades Prep (which is an abbreviation for Preparatory and which precedes Grade One) to Grade Six. Students typically commence school at age five. Primary teachers can therefore be expected to teach students ages five through twelve.
in the roles of participant, presenter, and program evaluator. This involvement proved central to the design of this study in three main ways: it provided the impetus for my interest in researching teacher change; it provided me with insight into the design and implementation of the various kinds of professional development programs available to teachers of mathematics in Victoria; and it focused my interest on determining whether professional development programs can act as appropriate vehicles for effecting the professional growth of teachers of primary mathematics.

A further factor that influenced this research (and, in particular, the selection of a research approach) related to my perspective on teacher change. A range of perspectives on teacher change exist (these will be discussed in Chapter 2). In this study I adopted a "learning perspective" (D.J. Clarke & Hollingsworth, 1994). Within this perspective teacher change is regarded as an ongoing process of professional growth or learning. The adoption of this perspective specifically channelled my interest towards describing and interpreting teacher change, and the professional growth of teachers over an extended period of time, rather than, for example, focusing on teachers' acquisition of skills.

My work-related interests, my initial review of the literature, and my adoption of a learning perspective on teacher change, directed the main interest of this study towards determining whether professional development programs can act as appropriate vehicles for effecting teacher professional growth.

1.3 Overview of the study

The major research question addressed by this study is:

Can professional development programs act as appropriate vehicles for effecting the professional growth of teachers of primary mathematics?

When considering methods appropriate to the investigation of this question, I was conscious of the need to select a research approach that would enable the study of process—specifically, the process of teacher professional growth. Case study was chosen as the research approach for use in this study as it would allow the complex process of professional growth for participants in a professional development program to be explored with the "depth, detail and individual meaning" (Patton, 1990) which I desired.
In particular, I decided to investigate the change and growth that occurred when teachers participated in a Victorian mathematics professional development program, Exploring Mathematics In Classrooms (EMIC), and the factors associated with this program (and professional development programs in general) that encourage, support or inhibit growth. The EMIC program was chosen because it possessed many characteristics of effective professional development programs grounded in the research literature.

The specific questions developed in order to investigate the major research question were:

What change do teachers report and demonstrate in practice when they participate in a mathematics professional development program?

What factors associated with mathematics professional development programs do teachers perceive as influencing their professional growth?

I conducted the study in two phases. Phase One involved an examination of the aims and purposes of the EMIC program in order to understand the intent of the program and to determine areas of expected change for EMIC participants. In this phase I examined the program’s documented aims and surveyed the EMIC program developers. I used the results of the survey of the program developers, together with the program’s documented aims, to develop a framework for focusing the investigation of teacher growth in the second phase of the study.

Phase Two involved the examination of the professional growth of six teacher participants in EMIC. Data were collected over 18 months in three key time periods: during the EMIC program; soon after the EMIC program; and 10–12 months after the EMIC Program. The data collection comprised: observations of the teachers working in their classrooms; observations of several EMIC sessions in which the teachers participated; structured interviews and informal conversational interviews with the teachers; completion of a questionnaire by the teachers; and the collection of sample teacher work documents. In addition, I used structured and informal interviews to collect data from the tutor who conducted the EMIC course investigated.

I developed two main techniques for analysing the data collected. I developed a data coding and classification system and different kinds of data displays. The analysis of the data enabled me to describe changes reported and demonstrated by the teachers, and factors associated with professional development programs they perceived as influencing professional growth. The analysis was assisted by the use of a theoretical
model—the Interconnected Model of Teacher Professional Growth (Teacher Professional Growth Consortium, 1994)—to represent the growth processes in which teachers engaged. Using this process of analysis I was able to conclude that professional development programs can act as appropriate vehicles for effecting the professional growth of teachers of primary mathematics—in terms of their own goals and purposes, and under certain conditions.

The findings of this study have implications for the design of mathematics professional development programs for teachers of primary mathematics. They also have implications for teacher professional development programs and teacher professional growth more generally, and for research related to these areas.
Chapter 2
Literature review

The review of the literature focuses on two main areas of interest central to this study. First, key assertions related to teacher change and effective professional development are examined. Second, the literature specific to teacher change in the context of mathematics education is discussed.

A difficulty associated with the selection of the literature for review in this chapter relates to the writing of this thesis part-time over an extended period. Changes in education have inevitably occurred across the time of this study, and a deliberate attempt has been made to incorporate both the literature that set the context for this study and more recent literature. Clearly the research design is a product of the theoretical literature related to teacher change and professional development available at the time the study commenced. Data analysis, however, was inevitably influenced by more recently developed alternative frameworks for describing teacher change. In a research project addressing the subject of change, it is entirely appropriate that the study accommodates to developments in the field.

Throughout this chapter the terms “change” and “professional growth” are used interchangeably, reflecting their use in the literature. While in much of the literature these terms are seen as synonymous, it should be noted that some writers make a distinction between them. These distinctions are noted as appropriate. The terms “professional development” and “staff development” are also used interchangeably and are seen to be synonymous throughout the discussion.

2.1 Key assertions related to teacher change and professional development programs

Whereas in the past educational change was often promoted through the development and publication of curriculum documents and texts, it is now widely acknowledged that in order to achieve significant and lasting change in education the central focus must be on teachers (see, for example, Brosnan, Edwards & Erickson, 1996; Guskey & Huberman, 1995; Herrera, 1996; National Council of Teachers of Mathematics, 1991a; National Research Council, 1989; Shaw & Jakubowski, 1991; Smith, 1996). This
section examines the growing body of literature related to teachers and educational change. A description of changing conceptions of teacher change is presented first. This is followed by an overview of various models of teacher change and teacher professional growth. A discussion of conditions identified as supportive of teacher change, and associated characteristics of effective professional development, is then provided. Finally, a description of different types of professional development programs is presented.

This section draws mainly on literature from Australia and the United States, due to the similarities in teacher education, school systems, and approaches to teacher professional development in those countries. The substantial literature arising from research in these two countries was considered particularly relevant to this Australian study of teacher professional growth.

### 2.1.1 Changing conceptions of teacher change

*Change as learning*

Historically, teacher change has been directly linked with planned professional development activities. Professional development became a major enterprise in education during the post-depression era (Howey & Vaughan, 1983). At that time it was based on a training paradigm that implied a deficit in teacher skills and knowledge (Guskey, 1986). Most professional development consisted of “one-shot” workshops aimed at teacher mastery of prescribed skills and knowledge. Professional development attempts based on this deficit model have been criticised throughout the literature. Researchers including Guskey (1986), Howey and Joyce (1978), McLaughlin and Marsh (1978), and Wood and Thompson (1980), have highlighted the ineffectiveness of professional development programs that have an overemphasis on this deficit approach. Others, including Fullan and Stiegelbauer (1991), Johnson (1989), and Lovitt and D.M. Clarke (1988), have provided convincing evidence of the failure of “one-shot” professional development approaches.

The clear ineffectiveness of attempts to effect teacher change through professional development programs based on the deficit-training-mastery model has provided the impetus for much research related to the process of change and professional development in recent years. A significant outcome of this research has been the shift in focus from earlier conceptions of change as something that is done to teachers (that is, change as an event) to change as a complex process that involves learning (Fullan &

Several authors have attempted to describe and classify different types or levels of teacher change. Schlechty and Whitford (1983) described three types of change sought by professional development activities. They suggested that professional development can serve an “establishing” function which promotes organisational change, a “maintenance” function which promotes change related to prevailing norms and practices, and an “enhancement” function which promotes improvement in individual teacher’s practice. A similar classification was prepared by Doyle (1990). In analysing the work of Joyce (1975) and Zeichner (1983) Doyle described five underlying themes related to teachers and change. These were:

- **the Good Employee**—where the emphasis is on preparing teachers in the prevailing norms and practices of classrooms and schools;
- **the Junior Professor**—where the emphasis is on extending teachers’ university curriculum core discipline knowledge, and learning how to teach as an apprentice of a skilled teacher;
- **the Fully Functioning Person**—where the emphasis is on the facilitation of teachers’ personal development;
- **the Innovator**—where the emphasis is on preparing teachers in the latest approaches utilising recent research and theory; and
- **the Reflective Professional**—where the emphasis is on fostering teachers’ reflective practices, including: observation, analysis, interpretation and decision making.

Doyle reported that most proposals for teacher education related to one of these change themes.

In attempting to describe different conceptions of teacher change, D.J. Clarke and Hollingsworth (1994) identified a number of alternative perspectives. They stated that the notion of “teacher change” is open to multiple interpretations, and that each interpretation could be associated with a particular perspective on teacher professional development. They described six perspectives of teacher change:

- **change as training**—change is something that is done to teachers, that is, teachers are “changed”;
- **change as adaptation**—teachers “change” in response to something, they adapt their practices to changed conditions;
- **change as personal development**—teachers “seek to change” in an attempt to improve their performance or develop additional skills or strategies;
• change as local reform—teachers “change something” for reasons of personal growth;
• change as systemic restructuring—teachers enact the “change policies” of the system;
• change as growth or learning—teachers “change inevitably through professional activity”, teachers are themselves learners who work in a learning community.

D.J. Clarke and Hollingsworth emphasised that these alternative perspectives on change are not mutually exclusive, and suggested that many are in fact interrelated. They further reported that the central focus of current professional development efforts most closely aligns with the “change as growth or learning” perspective. Within this perspective change is juxtaposed with learning, and it is regarded as a natural and expected component of the professional activity of teachers and schools. The notion of ongoing and life-long professional learning for teachers has been emphasised by several authors including Fullan and Stiegelbauer (1991), Jackson (1974), Johnson (1993; 1996a; 1996b), Schon (1983, 1987), and Stephens, Lovitt, D.M. Clarke and Romberg (1989). Jackson (1974) referred to a “professional growth approach” to professional development, where “the motive for learning more about teaching is not to repair a personal inadequacy as a teacher, but to seek greater fulfilment as a practitioner of the art” (p. 26). Similarly, Schon (1983) emphasised the importance of ongoing, critical reflection in teaching, in his notion of teachers as “reflective practitioners” (1983). More recently, Johnson (1996a) presented a case for reconceptualising teacher professional development as “opportunities for learning” to enable it to be “embedded into the ongoing work of the school” (p. 12). The Change as Growth or Learning perspective offers a particularly useful lens for considering the professional growth of the teachers in this study.

As reported above, authors use different terms to describe changing conceptions of teacher change. However, it appears that fundamental to “new” perspectives on teacher change and teacher professional development is a view of “teachers as learners” and “schools as learning communities”. An overview of the contemporary theories related to these areas is presented next.

**Teachers as learners**

The following discussion considers three main areas related to the notion of teachers as learners in the context of teacher change: the individual nature of learning; preparedness and readiness for learning; and conditions for change.
The individual nature of learning

Johnson (1993) stated that "an understanding of the personal and individual nature of teacher learning is essential for educators involved in facilitating change in teaching" (p. 12). He described George Kelly’s (1966) Personal Construct Theory, as offering one way of understanding the cognitive complexity of individual teacher learning. Personal Construct Theory is based on the premise that learning occurs through a process of construing events into a personal construct system. It suggests that people use familiar constructs, or knowledge-in-use, to translate change elements into a workable system. One’s personal constructs therefore are continually being defined or redefined. Johnson referred to the work of Olson (1980) who explored the implications of Personal Construct Theory for teachers facing change. Olson asserted that teachers make sense of innovative proposals in relation to existing goals, technologies and social relationships, and in an effort to minimise ambiguity, they seek familiar elements in the innovation "which they can construe to be like what is already well known" (Johnson, 1993, p. 12). Johnson stated that Personal Construct Theory provides one way of explaining the learning processes teachers are involved in as they undertake the challenge of construct change. He further reported that this conception of teacher learning is consistent with constructivist approaches to learning (which had gained prominence when this study of teacher professional growth commenced).

A further consideration related to understanding teachers as learners concerns the extent of learning required by a change proposal. Some change proposals require teachers to polish or "fine-tune" existing skills or methods, whilst others require the mastery of new strategies or methods (Joyce & Showers, 1981). Joyce and Showers reported that the "fine-tuning" of existing teacher repertoire is easier to achieve than the learning of new or different strategies. The complexities associated with making substantial change to teaching practice have also been highlighted by Fullan (1982) and Guskey (1985, 1986). It should be noted, however, that teachers are "good learners" capable of making significant change, if the conditions for learning are right (Johnson, 1989, p. 7).

Preparedness and readiness for learning

A body of research related to the preparedness and readiness of teachers to participate in change proposals and the subsequent effects on the change process has emerged (Doyle & Ponder, 1977; Johnson & Owen, 1986; Joyce, Bush & McKibbin, 1982; Showers, Joyce, & Bennett, 1987). In their California Staff Development Study,
Joyce, Bush and McKibbin (1982) identified the importance of characteristics that teachers “bring” to learning situations such as professional development programs. They interviewed 300 teachers, surveyed 3000, and held group discussions with several hundred more, in an attempt to explore their perceptions of their professional growth with regard to four areas: teaching; academic content; curriculum; and general knowledge. They developed five categories to describe teacher growth states: Omnivores; Active Consumers; Passive Consumers; Entrenched; and Withdrawn. Table 2.1 provides a summary of Joyce, Bush and McKibbin’s teacher growth states. An indication of the range of behaviours exhibited by teachers in different growth states can be gained through considering the first and last categories: teachers described as Omnivores, actively seek and initiate change, whilst those described as Withdrawn, actively resist and withdraw from change proposals. Joyce, Bush and McKibbin found that most teachers fall somewhere between these two extremes.

Table 2.1
Teacher Growth States (Joyce, Bush & McKibbin, 1982)

<table>
<thead>
<tr>
<th>OMNIVORES</th>
<th>ACTIVE CONSUMERS</th>
<th>PASSIVE CONSUMERS</th>
<th>ENTRENCHED</th>
<th>WITHDRAWN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actively seek, initiate and create opportunities for change</td>
<td>Actively seek change, but with less initiative than Omnivores</td>
<td>Rarely seek or initiate change, but may be drawn into change via positive environment and/or support</td>
<td>Rarely seek change, but may support proposals in line with comfort zones; will oppose or withdraw from proposals that are too different or difficult</td>
<td>Resistant to change and likely to actively withdraw or avoid change proposals</td>
</tr>
</tbody>
</table>

Doyle and Ponder (1977) have also highlighted different teacher types. Following discussions with experienced teachers, teacher participants of in-service programs and teachers enrolled in graduate courses, they suggested that most teachers are “pragmatic sceptics”; such teachers will consider issues of practicality when deciding whether or not to adopt and implement a change proposal. They reported that “in-service messages which are seen as practical will be incorporated, at least tentatively, into teacher plans” (1977, p. 2). McLaughlin and Marsh (1978) similarly noted the importance of what they call teacher efficacy. They suggested that professional development attempts which encourage a high sense of efficacy, that is, “a belief that the teacher can help even the most difficult or unmotivated students” (p. 85) are likely to produce more substantial teacher growth. Smith (1996) further noted the significant role of efficacy in the realisation of reform:
For the current reform to generate deep and lasting changes, teachers must find new foundations for building durable efficacy beliefs that are consistent with reform-based teaching practices. (p. 387)

Several writers have discussed the importance of teacher commitment to change. Huberman and Miles (1984) indicated that commitment may follow involvement in a change proposal rather than precede it. They reported that when teacher commitment is high there will be a greater impact on student learning outcomes and in turn a greater effect on teachers' responses to innovations. Whilst commitment is seen as important to the successful implementation of change proposals, Showers, Joyce and Bennett (1987) regarded flexibility in thinking and risk taking as more desirable characteristics, at least in the initial stages of change proposals.

Research into career cycles has also provided insights into teacher responses to change proposals. The work of Fenstermacher and Berliner (1985) determined that factors related to teachers' stages in the career cycle may affect their response to change proposals. As Murdoch (1992) stated, "These stages may be simultaneous and overlapping and vary between teachers—but each brings with it shifting priorities, needs, values and expectations" (p. 19). Johnson (1993) produced a number of generalisations about career development and teacher availability and willingness to undertake new learning. These generalisations are displayed in Table 2.2.

Whilst such generalisations can be useful in understanding possible stages of development for teachers, as Johnson (1993) stated, "such patterns need to be approached with caution" (p. 10). Researchers including Huberman (1988) and Fullan and Stiegelbauer (1991) have noted many different factors that can influence teachers' careers and their responses to innovations. Fullan and Stiegelbauer (1991) reported:

"Age, stage of career, life experiences and gender factors make up the total person. They affect people's interest in and reaction to innovation and the motivation to seek improvement. When we introduce new teaching methods, we often ignore these differences and treat teachers as if they were a homogeneous lot. (pp. 27-28)"

Whilst a variety of descriptors have been developed by authors to identify and categorise teacher growth states, there is much commonality between the characteristics described in the literature, and there is general agreement that teachers' responses to change proposals will be determined by a variety of factors related to professional needs, interests and career stage. There is also general agreement that those responsible for the design and implementation of professional development activities should consider the significant differences in teacher preparedness and readiness for learning.
Table 2.2
*Patterns in Teacher Career Development (Johnson, 1993, p. 10)*

<table>
<thead>
<tr>
<th>CAREER STAGE</th>
<th>CHARACTERISTICS</th>
</tr>
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<tbody>
<tr>
<td>Teachers entering the profession</td>
<td>• personal concerns of survival and discovery dominate</td>
</tr>
<tr>
<td></td>
<td>• energy focused on confronting complexity and demands of teaching</td>
</tr>
<tr>
<td></td>
<td>• many things &quot;new&quot;</td>
</tr>
<tr>
<td></td>
<td>• difficult to focus on any one change proposal</td>
</tr>
<tr>
<td>Beginning teachers—several years into career</td>
<td>• task-centred concerns</td>
</tr>
<tr>
<td></td>
<td>• focus on adding to teaching repertoire content, strategies, activities)</td>
</tr>
<tr>
<td></td>
<td>• increased professional credibility and confidence</td>
</tr>
<tr>
<td></td>
<td>• need for systematic reflection to make current practice explicit</td>
</tr>
<tr>
<td>Teachers five to fifteen years into career</td>
<td>• stabilised and available for diversification and change</td>
</tr>
<tr>
<td></td>
<td>• willingness to take risks, accept new responsibilities, look for career advancement</td>
</tr>
<tr>
<td>Midcareer teachers</td>
<td>• prone to boredom, diminished interest and enthusiasm</td>
</tr>
<tr>
<td></td>
<td>• stocktaking takes place; career shifts contemplated</td>
</tr>
<tr>
<td></td>
<td>• unlikely to embrace innovation with enthusiasm</td>
</tr>
<tr>
<td></td>
<td>• unlikely to make radical changes to teaching</td>
</tr>
<tr>
<td>Veteran teachers</td>
<td>• possible serenity or cynicism</td>
</tr>
<tr>
<td></td>
<td>• unlikely to be involved in new programs that require investments of energy and time</td>
</tr>
<tr>
<td></td>
<td>• could share expertise/classroom wisdom</td>
</tr>
</tbody>
</table>

Conditions for change

Several authors have described conditions necessary for teacher change and explored ideas related to the transfer of teacher learning into new classroom practices (Baker & Showers, 1985; Doyle & Ponder, 1977; Griffin, 1991; Hall, 1980; Hall & Loucks, 1978; Huberman & Miles, 1984; Joyce, Hersh & McKibbin, 1983; Joyce & Showers, 1981, 1982, 1988; Joyce & Weil, 1992; Romberg & Price, 1983; Showers, 1984; Sparks, 1983, 1986). This section describes the work of these authors and the implications of their findings for the design of effective professional development activities.

Joyce and his colleagues (1981, 1983, 1992) initially identified five conditions needed for teachers to learn and implement new repertoire: presentation of theory; modelling or demonstration; practice under simulated conditions; structured feedback; and coaching for application. Table 2.3 provides a description of each of these conditions.
Table 2.3

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>DESCRIPTION</th>
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</thead>
<tbody>
<tr>
<td>Presentation of theory</td>
<td>• provides knowledge base and rationale for change</td>
</tr>
<tr>
<td></td>
<td>• may take form of presentations, professional readings, discussions, video</td>
</tr>
<tr>
<td>Modelling or demonstration</td>
<td>• involves demonstration of teaching strategy either live</td>
</tr>
<tr>
<td></td>
<td>or through video or other media</td>
</tr>
<tr>
<td>Practice under simulated conditions</td>
<td>• involves experimentation with new skills through</td>
</tr>
<tr>
<td></td>
<td>practise with peers or students</td>
</tr>
<tr>
<td>Structured feedback</td>
<td>• provides opportunity to observe use of new skills and</td>
</tr>
<tr>
<td></td>
<td>to reflect on those observations</td>
</tr>
<tr>
<td></td>
<td>• observations may be made by self, peers or critical</td>
</tr>
<tr>
<td></td>
<td>friends</td>
</tr>
<tr>
<td>Coaching for application</td>
<td>• involves direct classroom support by peers, critical</td>
</tr>
<tr>
<td></td>
<td>friends or consultants who are competent with new</td>
</tr>
<tr>
<td></td>
<td>approach to teaching</td>
</tr>
</tbody>
</table>

Johnson (1993) stated that the major finding of extensive research into teacher learning of new repertoire by researchers, including Stallings (1981) and Sparks (1983, 1986), was that if the first four of Joyce and colleagues’ conditions listed in Table 2.3 were present, most teachers could develop new skills and knowledge and be able to apply these. However, unless some form of coaching or collegial support is present, most teachers would not transfer new repertoires into their regular practice. The work of Sharan and Hertz-Lazarowitz (1982), Kurth (1985), and Bennett (1987), further supports the assertions that unless adequate training is provided teachers do not acquire new teaching skills, and, unless adequate follow-up support is provided, implementation does not occur.

The question of what constitutes adequate training and adequate follow-up support has been further explored by Sparks (1983), Showers (1984), Joyce and Showers (1988), and Joyce and Weil (1992). In synthesising their findings, Johnson (1993) concluded that transfer of new teaching strategies is enhanced if:

- Demonstrations are multiple (usually up to ten demonstrations are needed for adequate modelling to occur), include modelling of the process to be followed, make explicit the consequence of the effort, and provide time to discuss the teaching strategy prior to and during the demonstration.

- Multiple opportunities to practise and receive feedback about the teaching strategy are provided. The feedback should be timely, make sense to the learner, be provided by a credible person and provide implications for subsequent teaching efforts.
• The transfer is forecast throughout the training cycle, the highest possible level of skill development is reached during training, the teacher understands how to adapt the new approach to students’ varying characteristics, and the teacher knows how to fit it into his/her existing repertoire.

• Coaching or reflective support is provided to the teacher in his or her regular classroom setting by peers who are skilled in working in this role with colleagues. The more that the desired strategy represents a major new teaching approach for the teacher, the more intense the reflective support and coaching must be to ensure effective transfer. (pp. 4-5)

Johnson stated that these findings “imply that change takes time and that specified help over an extended period is a necessary condition for teacher implementation of change” (p. 5). Baker and Showers (1985) have similarly reported that on-going, on-site collegial support is necessary for successful transfer of new and complex strategies into teachers’ repertoires.

Many authors have emphasised the importance of reflection in the process of teacher learning (Boud, Keogh & Walker 1985; Cooney & Krainer 1996; Knowles 1978; Schon, 1983, 1987; Smyth, 1982, 1984; Sprinthall & Sprinthall, 1983). Knowles (1978) stated that analysis of experience associated with teaching was the ideal methodology to promote teacher development because of the life-centred orientation of adult learning. As mentioned previously, the importance of critical reflection as a vital skill in teaching has been emphasised by Schon (1983, 1987). Boud, Keogh and Walker (1985) described reflection as “an important human activity in which people capture their experience, think about it, mull it over, evaluate it” (p. 26). They argued that reflection is a process of such significance that it demands “a specific allocation of time” (p. 26). More recently, Cooney and Krainer (1996), in discussing the complexity of teacher learning through inservice education, stated that there is:

a need for emphasizing a reflective component of inservice programs in which teachers explicitly consider the implications of their own learning experiences for their teaching and for creating contexts in which pedagogy and content are intertwined in a reform minded way. In short, teachers need to learn mathematics as they are expected to teach it. The notions of teacher change and of teachers being reflective practitioners (Schon, 1983, 1987) is predicated on the assumption that the teacher is a rational, thinking being and not the “object” of an inservice program. (p. 1162)

Several authors have attempted to describe the ways in which teachers respond to new learning and to change proposals. The work of Hall and Loucks (1978), Loucks and Pratt (1979), and Hall (1980), related to the development of the Concerns-Based-Adoption-Model (CBAM), provided important insights into factors related to teachers
as implementers of change. They identified two dimensions related to teacher implementation of change, an affective dimension and a behavioural dimension. The affective dimension was concerned primarily with what they referred to as Stages of Concern. Seven Stages of Concern about innovations were identified, including personal concerns, task related concerns, and concerns related to the impact of the change on others. The behavioural dimension, Levels of Use, examined the different levels of sophistication teachers demonstrate in the use of an innovation. These levels ranged from non-use, preparation and orientation, to the relatively passive mechanical and routine uses, to the more active and sophisticated uses of refinement, integration and renewal (Hall, 1980). The Stages of Concern and Levels of Use domains which were included as components of the Concerns-Based-Adoption-Model, highlighted the need to determine individual teacher's needs when planning effective professional development.

Romberg and Price (1983) organised change responses into two main categories: nominal change, which involves teachers in adopting "nothing but the labels" (Romberg & Price, 1983, p. 167), and actual change, where teachers are responsive to innovations and see themselves as having changed. They further sub-divided actual change into three more specific categories: technical, constructive and illusory change. Technical change involves teachers in adopting the rituals and routines of a change proposal without fully understanding the ideas that underpin it, but feeling confident that students will benefit from it. Illusory change sees teachers adopt the language and rituals of the innovation with no understanding of its underlying principles and with no conviction that it will benefit students. Constructive change occurs when teachers understand the principles of the innovation and are able to adopt and adapt it to suit their own purposes. Close links between Romberg and Price's nominal and actual change categories and the Levels of Use described by Hall and colleagues can be noted.

An alternative view of considering how teachers respond to change proposals has been explored by Olson (1980). As mentioned previously, Olson examined the implications of Personal Construct Theory for teachers facing change. He suggested that teachers make use of their personal construct system to actively react to change proposals and then transfer them into workable propositions. Thus responses to change proposals will be highly individual (Olson, 1980).

One factor related to the implementation of innovations that has been identified in the literature as a concern, is the extent to which teachers adapt innovations. Huberman and Miles (1984) and Griffin (1991), have highlighted the difficulties associated with
implementing change. In some studies teachers have altered or reshaped a change proposal to such an extent that important characteristics of the proposal have been lost (Huberman & Miles, 1984; Stephens, Lovitt, D.M. Clarke, & Romberg, 1989).

In summary, the research literature related to the notion of teachers as learners in the context of teacher change has highlighted that:

- teachers "are good learners who can fine-tune existing ways of working or master new approaches and implement these in classrooms, if a number of learning conditions are present" (Johnson, 1993, p.4);
- there is a need to recognise teachers' individual backgrounds, expectations, needs, interests and learning styles;
- teachers implement change in ways and at rates different from one another;
- change takes time and specified help over an extended period is a necessary condition for teacher implementation of change; and
- teachers adapt rather than adopt innovations.

Schools as learning communities

Authors including Joyce and Showers (1988), Lortie (1975), Little (1986), and Fullan, Bennett and Rolheiser-Bennett (1990), have recognised the powerful influence that the structure and organisation of a school can have on the process of teacher change and the success of professional development programs. A number of characteristics related to the organisation of schools that constrain change have been identified in the research literature (Campbell, 1982; Miles, 1981; Schmuck & Runkel, 1984). In summarising this research, Johnson (1989) outlined several obstacles to change that may exist in schools, including:

- diverse, loosely defined goals;
- lack of collaborative activity;
- vulnerability to special interest power groups;
- loosely coupled structures; and
- lack of incentive structures for teachers.

Johnson stated that these factors "in many ways set schools aside from the traditional model of a rational decision-making organisation that is tightly coupled" (1989, p. 18). The implementation of change proposals in schools is therefore especially problematic.

The work of Joyce, Bush and McKibbin (1982) provided a further alternative for viewing the effects of different school structures and organisations on change proposals. They suggested that school environments can be classified as either
Depressant, Maintenance-Oriented or Energising. Depressant schools are characterised by a survival atmosphere; the environment is unstable and effort is needed to simply “hold the school together”. Teachers in Depressant environments do not actively seek opportunities for change outside the school, and any change proposals considered must have immediate and obvious applicability. Maintenance-Oriented schools are characterised by their efforts to maintain stability and order “at all costs”. Teachers in these environments may be suspicious of change proposals that challenge existing instructional or organisational norms, roles or procedures. In Energising school environments, norms of cooperation, exploration and self-examination are present. Teachers in Energising schools actively seek, explore and implement curriculum change. These categories provide a useful base for considering teacher response to change proposals.

McLaughlin (1991) further emphasised the powerful influence of individual school-level organisation and structure. She contrasted the climates of two schools participating in similar changes related to changing school populations. Whilst she reported that one school climate reflected the “energy and excitement of a faculty working together”, she described the other as “a demoralized, discouraged setting where teachers look back to the ‘good old days’” (p. 74). McLaughlin identified the major difference between the two schools to be the degree of support evident for school-level collegiality and professional development.

In the research literature, considerable importance is placed on the notion of collegiality and collaboration amongst staff as a positive influence on teacher change (Fullan, Bennett, & Rolheiser-Bennett, 1990; Little, 1982). Rosenholtz (1989) identified collaboration in shared goal setting and implementation as an important characteristic evident in schools which had successfully implemented change. In a study exploring the effect of school climate on teachers, Hopkins (1990) found similar outcomes. He reported that schools where the greatest use of innovations was evident were “imbued with a spirit of collaboration, communication, and collegiality, and felt their work to be fully appreciated” (pp. 50–51). Whilst teachers regard interaction with other teachers as a major assistance to their professional growth, Joyce (1980) reported that there is often little opportunity in schools for teachers to work together. The availability of support and assistance within the local context of the school throughout the change process, has been identified as an important consideration in the design of effective professional development programs (Owen, Johnson, D.M. Clarke, Lovitt, & Morony, 1988; Showers, Joyce & Bennett, 1987).
Student and parent reaction towards change has also been identified in the literature as having significant influence on the teacher change process (Fullan & Stiegelbauer, 1991; Stephens, Lovitt, D.M. Clarke, & Romberg, 1989). The way in which students and parents respond can either actively support or severely stifle teachers in the process of change. Owen et al. (1988) noted the positive effect students and parents can have on the teacher change process when they are encouraged to participate in change proposals with teachers. The strong influence of student learning outcomes on teacher change has also been reported by authors including Guskey (1986).

The research indicates that just as teachers vary considerably in their availability and readiness to consider change, schools also differ in these regards. For teacher implementation of change to be most effective the "organisational health of the school" needs to be supportive to teacher learning (Johnson, 1989, p. 23). As Fullan and Hargreaves (1991) noted, change is about the culture of an institution, not just a single innovation.

In recent years, there has been much interest in the effect of school culture on teacher change, and subsequently on the reconceptualisation of schools as "learning communities" (Atkin, 1996; NSW Department of School Education, 1995; Johnson, 1996a, 1996b; Watkins & Marsick, 1993). The discussion that follows draws heavily on the recent work of Johnson (1996a, 1996b) related to schools as learning communities.

Whilst various definitions of the notion of schools as learning communities exist, Johnson (1996a) highlighted a number of features of schools as learning communities that link with the concept of Learning Organisations currently in vogue in the corporate world. These included:

- continuous learning;
- the goal of improvement or transformation;
- the valuing of learning by both individuals and the collective;
- learning integrated with work; and
- everyone’s learning being carefully planned and shared in systematic ways (p. 8).

Johnson (1996b) noted that the vision of schools as learning communities is not new:

In the literature similar notions have persisted over many years: schools as “communities of inquirers” (Dewey, 1938); “learning enriched or impoverished schools” (Rosenholtz, 1989); and schools as “learning academies” (Sparks 1994). (p. 7)
Johnson stated that many schools possessed characteristics of learning communities, and that most were somewhere along the way on the journey to "becoming" learning communities (1996a).

In considering current research on school and classroom change, Johnson (1996a) reported that change on two levels needed to be considered. The first level, which he described as first order change, is concerned with "striving to bring about the curriculum, teaching and learning changes required" (p. 9). The second level, or second order change, which must occur simultaneously with first order change, involves "working to provide the culture that will support the implementation of the change" (p. 9). The notion of a school as a learning community is focused on the culture of the school, and within that culture learning is central to every aspect of school work and life. As Johnson (1996b) noted:

> In a learning community, learning is the most important thing in the work of the school; staff and students go about this work in a way that enhances learning; and the emerging roles and relationships are aimed at maximising learning for all members of the community—principals, teachers and other staff, parents and other adult advocates, and of course children and young adults. (p. 8)

A significant feature in reconceptualising schools as learning communities is the importance accorded to staff learning. Researchers, including Fullan (1993) and Nias, Southworth and Campbell (1992), have emphasised the centrality of teacher learning to the improvement of student learning. As Fullan (1993) stated, "the skills and habits of everyday teachers are central to the future of learning societies" (p. 103). In describing the essential characteristics of schools as learning communities, Johnson (1996b) reported the need for a reconceptualisation of teacher professional development to broadly encompass "opportunities for learning" both in the workplace and outside on special occasions (p. 9).

The notions of teachers as learners and schools as learning communities and their concomitant perspective on professional development, are pivotal to learning perspectives on teacher change described in the literature. The following section outlines authors' attempts to generate models of the teacher change process.

### 2.1.2 Models of teacher change and teacher professional growth

As interest in teacher change has increased in recent years, many researchers have attempted to better understand the process of change and to develop means of
describing it. This section presents details of six different descriptions of the teacher change process developed over the past sixteen years.

Researchers, including Fullan (1982), have recognised that many professional development programs fail to consider the process of teacher change. These programs often attempt to change teachers’ beliefs and attitudes, with the expectation that changes in beliefs and attitudes will lead to changes in classroom practices and behaviours. In discussing such programs, Guskey (1986) pointed out the flaws in this view of change and provided an alternative model, which is shown in Figure 2.1. He stated that significant changes in beliefs and attitudes are likely to take place only after changes in student learning outcomes are evident, that is only after teachers have trialed change proposals in their classrooms and experienced first hand the change in student learning outcomes.

Guskey (1986) saw a number of implications of his change model for the design of effective professional development. These included the need to:

- recognise that change is a gradual and difficult process for teachers;
- ensure that teachers receive regular feedback on student learning progress; and
- provide continued support and follow-up after the initial training (pp. 9–10).

Figure 2.1. Guskey’s model of the process of teacher change (Guskey, 1986, p. 7).
Whilst Guskey’s model has provided useful insight into some aspects of teacher change, it has also been criticised for representing teacher change as a strictly linear process.

The work of Cobb, Wood and Yackel (1990) has provided an alternative view to Guskey’s linear notion of change. They worked intensively with one second grade teacher for a year, and with thirty other teachers during a professional development program conducted in a summer institute in the United States. They suggested that, rather than change being a linear process as described by Guskey, real changes in beliefs and attitudes occur at all stages of the professional development process. They reported that “Beliefs are expressed in practice, and problems or surprises encountered in practice give rise to opportunities to reorganize beliefs” (p. 145). Cobb, Wood and Yackel described a process similar to Guskey’s, where the importance of the need for teachers to attempt change in relation to the classroom context is emphasised. However they also proposed the importance of creating “cognitive conflict” in teachers’ minds. Cobb and his colleagues stated that challenging teachers’ approaches prior to them attempting to modify their classroom practice can be an effective motivator for change.

A further explanation of teacher change has been described by Johnson and Owen (1986). They suggested that teachers involved in change move through a number of identifiable stages, including: Recognition (of their existing repertoire), Refinement, Re-examination, Renovation and Renewal (where the nature, extent and use of their repertoire is re-evaluated and additions are planned). This process, which at first glance appears like Guskey’s model to be linear, would involve a continuous interplay between beliefs and practice similar to that suggested by Cobb, Wood and Yackel (1990).

Johnson’s more recent work, which emphasised change as an ongoing process in the professional lives of teachers, identified three broad stages in the change process: Initiation, Initial Implementation, and Institutionalisation (Johnson, 1996a). The Initiation stage involves the initial acceptance of the change proposal and the consequent decision to undertake the change. During the Initial Implementation stage, teachers begin to put the change proposal into practice. The final stage, Institutionalisation, is concerned with sustaining the implementation of the change, and during this stage teachers are involved in reaffirming their learnings, fine-tuning practice and making necessary changes in direction (Johnson, 1996a, p. 13).
In their discussion of teacher change models and mathematics education, Brown, Cooney and Jones (1990) referred to the work of Lappan, Fitzgerald, Phillips, Winter, Lanier, Madsen-Nason, Even, Lee, Smith and Weinberg (1988). Lappan and her colleagues made use of a model developed by Lewin (see Blanchard & Zigarmi, 1981) to design a two year study of change in middle-school mathematics. Lewin's model recognised three phases of teacher change: Unfreezing (where the intent is to motivate and prepare teachers for change), Changing (where new patterns of behaviour are learned), and Refreezing (where new behaviour is integrated into teachers' repertoires). Similarities exist between these phases and Johnson's (1996a) broad stages described earlier. Lappan and her colleagues attempted to guide teachers through each of these phases during their study. They reported positive outcomes in relation to successfully teaching the project aims using this model, however they also highlighted the need for substantial, long-term professional development which includes ongoing intellectual and emotional support, to ensure the success of the refreezing phase of the model (Brown, Cooney & Jones, 1990).

A further model of the teacher change process was developed by D.J. Clarke and Peter (1993), and later revised by an international research group interested in teacher professional growth, the Teacher Professional Growth Consortium (1994). They regarded teacher change as a learning process which they characterised as "teacher professional growth" (Teacher Professional Growth Consortium, 1994, p. 1). The Teacher Professional Growth Consortium suggested that change occurs through the mediating processes of "reflection" and "enactment", in four distinct analytic domains which encompass the teacher's world: the Personal Domain (Teacher Knowledge and Beliefs), the Domain of Practice (Classroom Experimentation), the Domain of Consequence (Salient Outcomes), and the External Domain (Sources of Information, Stimulus or Support). Their model recognised the complexity of professional growth through the identification of multiple growth pathways between the analytic domains. Its non-linear nature, and the fact that it recognised professional growth as an inevitable and continuing process of learning, distinguishes this model from others identified in the research literature. The distinction between the mediating processes of reflection and enactment is another feature of their model. This model, which is now known as the Interconnected Model of Teacher Professional Growth, is of particular interest to this study because of its link to the learning perspective on change described earlier. It is presented as Figure 2.2.
The Interconnected Model of Teacher Professional Growth is used in this study to represent teacher change and teacher growth. Further details of this model and its use in this study are presented in Section 5.3.2.

2.1.3 Conditions supportive of teacher change and associated characteristics of effective professional development programs

The review of the teacher change research literature contained some key assertions related to teacher change and a number of conditions which appear to support teacher change. In summary, these conditions are:

- **time**—teacher change involves a complex process of learning that requires sustained professional activity over extended periods;
- **contextual relevance**—change initiatives need to have workplace relevance;
- **opportunities for action and reflection**—change involves a continual and complex cycle of action and reflection;
- **support/collegiality**—support and assistance throughout the change process is needed in technical, cognitive and emotional domains;
• professional responsibility, collaboration and decision making—there is a need for active, personal involvement in directing one's professional learning; and
• immersion and involvement in learning communities—environments where ongoing learning is valued and practised, and collaborative work cultures are present, support change implementation.

This section considers the association of these conditions with the design and implementation of teacher professional development activities. In particular it provides an overview of the features characteristic of effective professional development that have been identified in the literature.

Drawing on "theoretical perspectives and practical experience", Owen, Johnson, D.M. Clarke, Lovitt and Morony (1988, p. 13), outlined nine principles for effective professional development. Following their synthesis of the research literature, and their analysis of "best" professional development practice operating across Australia, they reported that to achieve lasting educational change professional development should:

• address issues of concern recognised by the teachers themselves,
• take place as close as possible to the teacher's own working environment,
• take place over an extended period of time,
• have the support of both colleagues and the school administration,
• provide opportunities for reflection and feedback,
• enable participating teachers to feel a substantial degree of ownership,
• involve a conscious commitment on the part of the teacher,
• involve groups of teachers rather than individuals from a school,
• use the services of a consultant and/or critical friend. (p. 15)

Owen and colleagues stated that professional development activities could be assessed for the degree to which they address each of these principles. They assumed that the most effective professional development would possess each characteristic.

In his detailed analysis of the research related to the role of professional development in facilitating professional growth, D.M. Clarke (1993) highlighted the need for professional development activities to vary according to factors including:
• the needs and interests of teachers;
• available time;
• cost;
• scope of the change; and
• available support.

While recognising this, he also reported, however, that "the literature provides a basis for establishing several features or principles of staff development, which are likely to increase the chances of teachers' professional development" (1993, p. 64). In summarising the research literature, D.M. Clarke (1994) identified ten of these principles. He claimed that staff development should:

1. Address issues of concern and interest, largely (but not exclusively) identified by the teachers themselves, and involve a degree of choice for participants.

2. Involve groups of teachers rather than individuals from a number of schools, and enlist the support of the school and district administration, students, parents, and the broader school community.

3. Recognize and address the many impediments to teachers' growth at the individual, school, and district level.

4. Using teachers as participants in classroom activities or students in real situations, model desired classroom approaches during inservice sessions to project a clearer vision of the proposed changes.

5. Solicit teachers' conscious commitment to participate actively in the professional development sessions and to undertake required readings and classroom tasks, appropriately adapted for their own classroom.

6. Recognize that changes in teachers' beliefs about teaching and learning are derived largely from classroom practice; as a result, such changes will follow the opportunity to validate, through observing positive student learning, information supplied by professional development programs.

7. Allow time and opportunities for planning, reflection and feedback, in order to report successes and failures to the group, to share "the wisdom of practice", and to discuss problems and solutions regarding individual students and new teaching approaches.

8. Enable participating teachers to gain a substantial degree of ownership by their involvement in decision-making and by being regarded as true partners in the change process.

9. Recognize that change is a gradual, difficult, and often painful process, and afford opportunities for ongoing support from peers and critical friends.

10. Encourage participants to set further goals for their professional growth. (p. 38)

Many similarities between the principles described by D.M. Clarke (1994) and those described by Owen and colleagues (1988) can be noted. This is to be expected
considering that D.M. Clarke was one of the researchers who contributed to the
development of the list of principles published by Owen and colleagues. Two of the
principles that distinguish D.M. Clarke’s more recent work relate to the need to
recognise and address the many impediments to teacher growth, and the importance of
encouraging teachers to set goals for their future professional growth.

Cooney (1994) also recognised that “While no single effective method of promoting
change in the classroom has been identified, there are several characteristics of in-
service programs that deserve attention” (p. 25). In his analysis of mathematics
inservice education, he noted that two comprehensive inservice projects conducted in
the United States, the Urban Mathematics Collaborative Project (which addressed
four themes: socialisation and networking, increased knowledge of mathematics
content, teacher professionalism, and teacher leadership) and the QUASAR project
(which focused on content, instructional skills, instructional strategies, and classroom
management), shared three key characteristics:

collaboration among various professionals, professional involvement
over an extended period of time, and creating an exploratory
atmosphere similar to what teachers are encouraged to create with
their students. (Cooney, 1994, p. 26)

Cooney emphasised the importance of teachers reflecting on their role in social
contexts to effect change. He suggested that “It is not just the technical aspects of in-
service programs—what gets emphasized and what doesn’t—that makes a difference
but also the contexts that embody those technical aspects” (p. 32).

The work of Johnson (1993; 1996a), has provided further delineation of features of
effective professional development. In 1993, Johnson reviewed the literature related to
teacher individual differences, teachers as learners, and teacher change, and identified
seven conditions for effective professional development. Similar to the work of
D.M. Clarke (1993) and Owen and colleagues (1988), Johnson’s conditions focused on:
addressing issues of concern recognised by teachers; utilising teachers’ own working
environments; involving groups of teachers rather than individuals; implementing
professional development over extended periods of time; having internal and external
support; and, enabling a substantial degree of teacher ownership. A further condition
emphasised by Johnson related to the inclusion of what he called “the general
components found to be necessary for change in practice: theory, challenge, explicit
modelling and demonstration, practice, feedback, and application with opportunities
for support and systematic reflection” (p. 14). Johnson stated that “The evidence is
overwhelming that if teachers are to change the way they work they must have the
benefit of these conditions in their inservice teacher education program” (1993, p. 15).

Johnson’s later work (1996a), which emphasised the need to reconceptualise
professional development as “opportunities for learning” (p. 11), saw the refinement
of five criteria for effective professional development. He reported that the evidence is
mounting that effective models of staff development fulfil five criteria:
1. They are context specific, context bound and practical (i.e. particular settings and
times are considered in selecting and designing appropriate activities; work-
embedded learning opportunities are optimised; issues of concern recognised by
teachers themselves are addressed).
2. They are focused on individuals and organisations (i.e. there is an integrated blend
of individual development and organisation development).
3. They are collaborative (i.e. cooperative and collaborative professional development
practices are employed).
4. They are participatory, analytical and reflective (i.e. sound adult learning
principles are utilised; multiple forms and models are utilised; formal and informal
elements are included; ownership and commitment are encouraged).
5. They are developmental and ongoing (i.e. extended periods of time are utilised;
staff commitment to follow-through is evident) (see p.11).

As evidenced in the discussion above, there is a strong resemblance between the
various lists of features of effective professional development identified in the
literature. While authors have developed different descriptors to label identified
features, and different ways of categorising them, it is obvious that there are several
generally agreed characteristics of effective professional development that are
grounded in the literature. One way to summarise these characteristics is to link them
to the conditions supportive of teacher change listed earlier. Table 2.4 presents a
summary of characteristics of effective professional development as they relate to the
list of conditions supportive of teacher change previously presented. In the next
section, a description of the range of professional development types that has emerged
in recent years will be presented.
Table 2.4

Conditions Supportive of Teacher Change and Associated Characteristics of Effective Professional Development

<table>
<thead>
<tr>
<th>CONDITIONS SUPPORTIVE OF TEACHER CHANGE</th>
<th>ASSOCIATED CHARACTERISTICS OF EFFECTIVE PROFESSIONAL DEVELOPMENT</th>
</tr>
</thead>
</table>
| • Time—change involves a complex process of learning that requires sustained professional activity over extended periods | • is developmental  
• takes place over extended periods of time  
• involves staff commitment to follow-through |
| • Contextual relevance—change initiatives need to have workplace relevance | • addresses issues of concern and interest recognised by teachers  
• optimises work-embedded learning opportunities |
| • Opportunities for action and reflection—change involves a continual and complex cycle of action and reflection | • encourages participation  
• encourages analysis  
• encourages reflection |
| • Support/collegiality—support and assistance throughout the change process is needed in technical, cognitive and emotional domains | • encourages collegiality  
• provides opportunities for ongoing support from colleagues, consultants and/or critical friends |
| • Professional responsibility, collaboration and decision making—there is a need for active, personal involvement in directing one's professional learning | • employs cooperative and collaborative practices  
• encourages substantial teacher ownership of change implementation  
• regards teachers as partners in the change process |
| • Immersion and involvement in learning communities—environments where ongoing learning is valued and practised, and collaborative work cultures are present support change implementation | • is embedded into the ongoing work of the school  
• integrates individual and organisational development |

2.1.4 Types of professional development

A wide variety of approaches to professional development design and implementation has emerged in recent years. This section provides an overview of professional development approaches related to mathematics education described in the literature.

Owen, Johnson, D.M. Clarke, Lovitt and Morony (1988) identified eight approaches to professional development in mathematics education. These were:

• **structured course**—an organised course conducted over a fixed time (e.g. ten week period), which involves teacher commitment to attend sessions and incorporate course content into classroom practice, and consists of discussion of themes and results of teacher explorations in their classrooms between sessions;

• **sandwich course**—two sessions between which teachers explore themes and content presented in the first session and reflect on outcomes during the second session;
• *in-school intensive*—negotiated sessions conducted within a school to address particular needs or interests of staff;

• *school cluster groups*—groups of staff from different schools form a network to consider new approaches;

• *postal model*—teachers trial materials/ideas mailed through the post and provide feedback to a regional consultant or contact;

• *pre-service model*—student teachers trial new approaches during school placements under the guidance of supervising teachers;

• *peer tutoring*—colleagues provide support for one another in the use and incorporation of new approaches; and

• *activity documentation*—networks of teachers gather to share and document successful new approaches.

Each one of these professional development types acknowledges, to varying degrees, the principles of effective professional development identified by Owen and colleagues (1988) that were listed in the previous section. Owen and colleagues stated that each of these approaches could be viable alternatives, depending on the particular circumstances in which the professional development activity was to be planned and conducted. They reported that the selection of a professional development approach to use in a given situation should be based on client needs and interests, and they stated that consultation should occur with the clients to determine the most appropriate approach. They also reported that over an extended period of time more than one approach, or a hybrid, could be used with the same group of teachers. Owen and colleagues purposefully excluded from their list of recommended professional development types the "one shot" approach (where one workshop is conducted in isolation) often utilised in the past, as it is seen to be in direct conflict with many of the principles of effective professional development grounded in the literature, and it has been found to have little lasting effect on teacher change (Fullan & Stiegelbauer, 1991; Johnson, 1989).

A further analysis of professional development approaches has been completed by Sparks and Loucks-Horsley (1990). They identified five professional development approaches:

• an individually guided staff development approach (where teachers plan and pursue activities they feel will develop their own learning);

• an observation/assessment approach (where teachers are observed and receive feedback related to their classroom practice);
• a development/improvement approach (where teachers are involved in curriculum
design and development, or school improvement processes);
• a training approach (where the focus is on teachers acquiring knowledge or skills
through instruction); and
• an inquiry approach (where teachers identify an area they would like to work on,
collect data and make changes based on their interpretation of that data).

Sparks and Loucks-Horsley (1990) reported that the training approach is the most
widely used form of professional development and therefore it is the model that has
been most thoroughly investigated by researchers. They highlighted criteria for
effective professional development similar to those identified by Owen et al. (1988),
and suggested that factors that would continue to be important regardless of what is
learned in the future about other professional development types include:

(a) schools with norms that support collegiality and experimentation; (b) district and building administrators who work
with the staff to clarify goals and expectations and actively commit
to and support teachers’ efforts to change their practice; (c) efforts
that are strongly focused on changes in curricular, instructional, and
classroom management practices with improved student learning as
the goal; and (d) adequate, appropriate staff development
experiences with follow-up assistance that continues long enough for
new behaviors to be incorporated into ongoing practice. (p. 247)

Sparks and Loucks-Horsley (1990) also emphasised that there are many questions
related to effective professional development that remain unanswered. They reported
that:

The need is great for well-designed long term studies of school-
 improvement efforts based on staff development. The field of staff
development seeks a solid base that moves beyond description and
advocacy to a better understanding of those factors that support and
improve classroom practice. (p. 248)

An alternative approach to professional development has been identified more
recently by Cooney and Krainer (1996). They described inservice education as placing
“a twofold demand on mathematics educators” (p. 1168). They stated that firstly
inservice education requires attention to state-of-the-art developments in the field, and
secondly that these developments need to be seen to be relevant to teachers’ practical
concerns to avoid rejection of change proposals. Cooney and Krainer reported that
“The linkage of these two demands requires that barriers between theory and practice
be dissolved if inservice is to provide a context for meaningful reform” (p. 1169).

Cooney and Krainer stated that teacher education should be embraced as “a process
of inquiry” (p. 1176), with the integration of theory and practice being central to
inservice activities. They reported that process-oriented inservice activities offer opportunities to interconnect pedagogical and didactical aspects of teaching. One program, titled Pedagogy and Subject-Specific Methodology for Teachers (PFL), described by Krainer (1994), attempted to do this through three years of intensive theoretical and practical work. Guiding principles of the Pedagogy and Subject-Specific Methodology for Teachers program (Krainer, 1994) included:

- stressing the importance and interconnectedness of pedagogical and didactic aspects of teaching and learning;
- using teachers' practical experiences to identify strengths on which to build the program;
- conducting action research which emphasizes the systematic reflection of practitioners;
- promoting the professional exchange of knowledge among teachers;
- connecting individual and social learning experiences;
- promoting the further development of theory and practice;
- encouraging a sense of active, reflective, self directed and self sustaining education and professional development among teachers. (pp. 105–106)

The work of Krainer (1994) and Cooney and Krainer (1996) suggests that professional development activities should intertwine theory and practice. One means by which this might be achieved is through action research, another is through the structured inclusion of classroom experimentation and teacher reflection.

A further professional development approach that has only recently been adopted by the teaching profession is the strategy of case-based professional development (Barnett, 1991; Louden & Wallace, 1996; McRobbie & Shulman, 1990; Wasserman, 1993). Cases, for the purposes of teacher professional development, are candid, dramatic, accessible representations of teaching events or series of events. They offer a problem-based snapshot of an on-the-job dilemma and are consciously designed to provoke discussion. A growing body of research has emerged from the Mathematics Case Methods Project coordinated by the WestEd Educational Research Laboratory in San Francisco (Barnett, 1991; Barnett & Tyson, 1993; Gordon & Heller, 1995; Gordon & Tyson, 1995; Heller, 1995; Tyson, Barnett & Gordon, 1995). This research has demonstrated that a case-based approach to professional development can provide a powerful stimulus for teacher change.

The diversity of approaches to professional development in current use in mathematics education defies simple summary. However, it appears that the deliberate link
between espoused theory and classroom practice should feature prominently, and be the subject for regular teacher reflection.

In the next section a discussion of the research literature specifically related to teacher change in the context of mathematics education will be presented.

### 2.2 Teacher change in the context of mathematics education

This section is presented in two parts. First, the climate of change in mathematics education in which this study is contextually situated is discussed. Second, research studies related to mathematics teachers and change are described.

#### 2.2.1 The climate of change in mathematics education

This section sets a broad context for this study through describing the climate of change in mathematics education evident when this study was conducted. In particular, forces shaping changes in mathematics education during the 1980s and early 1990s are discussed, and an overview of the changes that were recommended at that time is presented.

**Forces shaping changes in mathematics education**

An analysis of the literature identified three key forces shaping changes in mathematics education during the 1980s and the early 1990s. These are: changing conceptions of mathematics curriculum content; the influence of developing technology; and changing views of learning. These forces are distinct, yet inextricably linked. Whilst each one is treated separately in the discussion that follows, reference to their interrelationship is made as appropriate.

**Changing conceptions of mathematics curriculum content**

Changing conceptions of mathematics curriculum content have been highlighted by several writers including Romberg (1984), Ernest (1989), Dossey (1992) and Nickson (1992). While these writers have different approaches to describing changing conceptions, some commonality exists in their ideas.
In discussing what he termed the “crises in mathematics education”, Romberg (1984) stated that major problems facing mathematics education “stem from a narrow mechanical concept of education” (p. 11). He described a common conception of mathematics as “a static collection of concepts or skills to be mastered one by one” (p. 6). Romberg reported that four factors have contributed to this view of mathematics:

- the over fragmentation of mathematics;
- the reinforcement of this fragmentation via tests that emphasise the independence rather than the interdependence of ideas;
- the limited view of mathematics held by most teachers; and
- the assumption that there is a strict, partial ordering to mathematics.

Romberg noted that too often “the acquisition of a prescribed amount of knowledge under competitive conditions and time pressures constitutes mathematics instruction” (p. 11), and he identified the need for educators to reconsider ideas about mathematics, learning and teaching (p. 19).

Romberg recommended that a contemporary curriculum theory needs to be constructed, based on a “holistic way of viewing the world” (p. 16). He contrasted the narrow view of mathematics listed previously with a view where the connectedness of mathematical ideas is regarded as critical and “where mathematics is seen as a way of communicating” (p. 20).

Ernest (1989) outlined three main conceptions of mathematics which have been observed to occur in the teaching of mathematics, and in the philosophy of mathematics and science. These are:

- the instrumentalist view—mathematics “is a set of unrelated but utilitarian rules and facts”;
- the Platonist view—mathematics is “a static but unified body of certain knowledge”; and
- the problem-solving view—mathematics is “a dynamic, continually expanding field of human creation and invention, a cultural product” (p. 250).

Ernest stated that all teachers have a conception of mathematics based on one of these views, whether it is consciously articulated or an implicitly held belief. He further noted that direct links exist between these views of mathematics and teachers’ roles, their intended learning outcomes, their use of curricular materials, and their views of learners. A summary of these links is provided in Table 2.5.
Table 2.5
A Summary of Ernest's Views of Mathematics and Associated Teaching and Learning Considerations (Ernest, 1989)

<table>
<thead>
<tr>
<th>VIEW OF MATHEMATICS</th>
<th>TEACHER'S ROLE</th>
<th>INTENDED OUTCOME</th>
<th>PATTERNS OF CURRICULAR MATERIALS USE</th>
<th>VIEW OF LEARNERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSTRUMENTALIST</td>
<td>Instructor</td>
<td>Skills mastery with correct performance</td>
<td>Strict adherence to a text or scheme</td>
<td>Submissive and compliant</td>
</tr>
<tr>
<td>PLATONIST</td>
<td>Explainer</td>
<td>Conceptual understanding with unified knowledge</td>
<td>Enriched modification of textbook approach</td>
<td>Passive receivers of knowledge</td>
</tr>
<tr>
<td>PROBLEM-SOLVING</td>
<td>Facilitator</td>
<td>Confident problem-posing and problem-solving</td>
<td>Mathematics curriculum constructed by teacher or school</td>
<td>Autonomous, active constructors of understanding</td>
</tr>
</tbody>
</table>

In describing the research literature related to views of mathematics, Dossey (1992) reported that a "rich mosaic" of conceptions of the nature of mathematics has emerged, ranging from "axiomatic structures to generalized heuristics for solving problems" (p. 39). He stated that conceptions "fall along an externally-externally developed continuum" (p. 45), where the external conceptions closely relate to Platonic views (mathematics is seen to be a body of knowledge that is transmitted to students, similar to Ernest's Instrumentalist and Platonic categories), and internal conceptions are more in line with Aristotelian views (where mathematics is seen to be a personally constructed set of knowledge, similar to Ernest's Problem-solving view).

Dossey highlighted the fact that the different conceptions of mathematics located at each end of the continuum—"mathematics as a dynamic, growing field of study", and "mathematics as a static discipline, with a known set of concepts, principles, and skills" (p. 39)—can create tension for many teachers. He reported that whilst teachers generally would like to agree with Aristotelian-like view of mathematics, many "retreat" in practice, showing a strong predilection for Platonic views.

Alternative views of mathematics have been discussed by Nickson (1992). She stated that by considering two traditions of mathematical thought, the "formalist" tradition and a "growth and change" view of mathematics, an idea of the range of perceptions that exist can be gained. The "formalist" view, as described by Nickson, sees mathematics consisting of immutable truths and unquestionable certainty, "waiting 'out there' to be discovered" (p. 103). The "growth and change" view, in contrast, sees mathematics as being created and changed in response to social and cultural phenomena. Nickson reported that a lack of success of methods that reflect formalist
perspectives has led to inquiries related to mathematics teaching in the United Kingdom and the United States. It could be suggested then, that one impetus for change in mathematics education stems from educators’ views of the inappropriateness of formalist perspectives of school mathematics.

The influence of developing technology

The availability of increasingly sophisticated technology in work, home and school environments since the advent of personal calculators in the 1970’s has shaped changes in mathematics education in two main ways. First, it has caused a reconsideration of what mathematics students need to learn. Second, it has presented both need and opportunity for change in the way mathematics is taught and learned in schools (Shuard, 1986).

The rapid increase in access to and use of technologies, in particular calculators and computers, has encouraged both a change in emphasis on specific mathematical content to be learned and the development of new mathematical topics. In summarising the impact of technology on the mathematics curriculum, the National Council of Teachers of Mathematics (NCTM) stated:

- Some mathematics becomes more important because technology requires it.
- Some mathematics becomes less important because technology replaces it.
- Some mathematics becomes possible because technology allows it.

(1991b, Transparency 34)

Whilst a comprehensive account of the extent of the changes in mathematics content associated with developing technologies is beyond the scope of this review, readers are referred to the work of Balacheff and Kaput (1996), Groves (1996; 1997), Shuard (1992), and Wheatley and Shumway (1992) for additional details.

A further way in which technologies are shaping change in mathematics education relates to methods for teaching and learning mathematics. The effective use of current and future technologies in school programs demands new styles of teaching and learning. For example, teachers need to design learning opportunities that take into account the power of technologies as both computational and instructional tools. One consequence expected is a shift in the focus of teaching from the transmission of facts and procedures to the exploration and investigation of concepts and structures (Kilpatrick, 1996).
In summary, observations related to positive influences of developing technologies on mathematics education have included:

- the exploration and generation of mathematical ideas that extend beyond the manual computational abilities of students (Groves, 1997; Shuard, 1992);
- the provision of student access to more sophisticated mathematics through increased opportunities for exploration and problem solving (Balacheff & Kaput, 1996; Groves, 1997; Shuard, 1992; Wheatley & Shumway, 1992); and
- the relocation of the focus of teaching and assessment from facts and procedures to concepts and structures (D.J. Clarke, 1996; Kilpatrick, 1996; Wheatley & Shumway, 1992).

**Changing views of learning**

In recent years, outcomes of research related to the process of learning mathematics have led to significantly different views of how the subject is learnt, and consequent recommendations for how it should be taught.

Contemporary visions for what it means to learn mathematics draw on theories of knowledge and learning that contrast sharply with "traditional" mathematics teaching practice (see, for example, Confrey, 1990; Stigler & Stevenson, 1991). Traditional approaches presume an epistemology in which there exists a fixed, static set of mathematical knowledge and skills, and a behaviourist/empiricist view of learning (Greeno, Collins & Resnick, 1996) based on the compliant receiving of knowledge and skills from a recognised authority. Contemporary views see mathematics as a dynamic, growing field of study and learners as autonomous, active constructors of knowledge requiring a classroom environment that emphasises engagement and active participation (Knapp & Peterson, 1995).

**Constructivist** theories of learning, which developed out of the work of Piaget, and were later explored by others (notably von Glasersfeld, 1978, 1984, 1989; and Steffe and colleagues 1983, 1988), have strongly influenced change in mathematics education. Whilst the literature related to constructivism is extensive, and a detailed examination of the many varied interpretations of it is beyond the scope of this review, the articulated support for constructivist views of learning by mathematics educators during the 1980s and early 1990s warrants some discussion.

Fundamental to constructivism is the notion that "knowledge is not passively received but actively built up by the cognizing subject" (von Glasersfeld, 1989, p.182). Learning therefore does not occur through the transmission of pre-formed knowledge by teachers, but rather as students "construct their own meanings from, and for the ideas,
objects and events which they experience” (Australian Education Council, 1991, p. 16). While there are varying opinions as to the degree to which different factors (for example social factors) influence individuals’ constructions of mathematical knowledge (see Malone & Taylor, 1993; Davis, Maher & Noddings, 1990b), some basic tenets of constructivism have been summarised by Clements and Battista (1990):

- Knowledge is actively created or invented by the child, not passively received from the environment.
- Children create new mathematical knowledge by reflecting on their physical and mental actions. Ideas are constructed or made meaningful when children integrate them into their existing structures of knowledge.
- No one true reality of the world exists, only individual interpretations of the world. Thus, learning mathematics should be thought of as a process of adapting to and organizing one’s quantitative world, not discovering preexisting ideas imposed by others.
- Learning is a social process in which mathematical ideas and truths, both in use and meaning, are cooperatively established by the members of a culture, and learners are involved in explanation, negotiation, sharing, and evaluation.
- Preeminent value is given to the development of students’ personal mathematical ideas and the promotion of a view of mathematics as sense making rather than the learning of set procedures.

Implications of the acceptance of constructivist principles for school mathematics include: that mathematics learning be regarded as an active process; that students be encouraged to construct mathematical knowledge and to reflect on that knowledge; and that teachers attempt to understand and respond to the mathematical constructions students make. For many teachers, the acceptance of constructivist principles and the associated valuing of student-constructed mathematics would require significant change in their beliefs about learning and in their approaches to teaching. As Brown (1994) reported, there are many challenges associated with adopting constructivist models of learning:

> What the new theories ask is so hard. It is easier to organize drill and practice in decontextualized skills to mastery, or to manage 164 behavioural objectives, than it is to create and sustain environments that foster thought, thought about powerful ideas. We are asking a great deal from everyone in the learning community. (p. 11)

Details of specific recommendations for change in mathematics education during the time this study was conducted are presented next.
Overview of recommended changes to mathematics education

The literature selected for discussion in this section is primarily drawn from Australia, the United States and the United Kingdom, to reflect the concurrent and analogous changes in mathematics education experienced in those countries during the 1980s and early 1990s.

Recommendations related to mathematics curriculum content

Whilst mathematics curriculum content changes occurred at all levels of schooling, the following discussion will focus mainly on changes to the primary mathematics curriculum, central to the interest of this study.

Recommendations for changes to primary mathematics content have been relatively consistent between Australia, the United States and the United Kingdom (see Australian Education Council, 1991; Cockcroft, 1982; National Research Council, 1989). During the 1980s and early 1990s a very different set of mathematical objectives from those evident earlier this century was developed (National Research Council, 1989). The previous emphasis on arithmetic and geometry, once considered adequate for the development of most people’s daily life skills, was considered far too narrow:

Now much more than arithmetic and geometry, mathematics today is [perceived as] a diverse discipline that deals with data, measurements, and observations from science; with inference, deduction, and proof; and with mathematical models of natural phenomena, of human behaviour, and of social systems. (National Research Council, 1989, p. 31).

Recommendations related to both the goals for school mathematics and the scope of the curriculum represented a significant broadening of mathematics curriculum content. In addition to developing students’ mathematical competence, the goals articulated in more recent curriculum policies and documents emphasised: mathematical confidence; mathematical appreciation; problem solving; mathematical communication; and mathematical processes (see, Australian Education Council, 1991; National Council of Teachers of Mathematics, 1989). Descriptions of the scope of mathematics in those documents similarly emphasised mathematical understanding and processes in addition to skills and knowledge of facts and procedures. Readers are referred to A National Statement on Mathematics for Australian Schools (Australian Education Council, 1991), the Curriculum and Evaluation Standards For School Mathematics (National Council of Teachers of Mathematics, 1989), and Cockcroft (1982) for details of
specific recommendations for change made in Australia, the United States and the United Kingdom respectively.

In addition to the publication of statements related to changes in the scope of the content to be covered in school mathematics programs, significant changes in the way in which curriculum content is treated in terms of program design and management were recommended. Whereas previously the content sequence and procedure of many mathematics curriculum programs was determined and fixed via curriculum documents and texts, recommendations that the design and management of curriculum programs be primarily controlled by teachers were made. These recommendations recognised the need for the development of new curriculum programs responsive to the needs of different students and teachers, as well as the important role teachers had to play in mathematics curriculum change. Such recommendations gave new emphasis to the professionalism of mathematics teachers. In the United States for example, the NCTM publication, *Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics, 1991a), described the important role of teachers in implementing the mathematics education reform recommendations outlined in the Curriculum and Evaluation Standards. The central role of teachers in the realisation of changes to mathematics education will be discussed in more detail later in this chapter.

However, in the last few years as work on this thesis has progressed, the directions taken in some countries related to mathematics curriculum development have not followed the recommendations previously outlined, and in some cases direct opposition to them has emerged in political, educational and public forums. In the United Kingdom, for example, school mathematics programs in recent years appear to have become driven by prescriptive assessment of the skills outlined in their mandated national curriculum. The publication of the *National Curriculum for England and Wales* (Department of Education and Science and the Welsh Office, 1989) received a mixed reaction. Whilst it was welcomed by some educators, others consider it a regressive step for mathematics education in those countries. Burton (1996) surmised:

The English and Welsh experience is of slow development sustained through considerable expenditure on teacher education and support which, over the period 1982–1988 and culminating in the introduction of the GCSE [General Certificate of Secondary Education], led to many teachers reconsidering their views on mathematics, its learning and teaching and consequently their practices. This has been followed by rapid governmental educational changes re-asserting the primacy of an assessment-led system in a highly dogma-driven environment which has induced confusion and low morale in teachers. (p.46)
In the United States, whilst organisations such as the NCTM have actively worked to promote the implementation of the recommendations made in the Standards documents, several opposition groups have rallied to have the Standards revoked, favouring a “Back-to-Basics” movement. Such groups criticise many of the recommendations discussed earlier claiming that they promote a mathematics curriculum that is not sufficiently rigorous. It is significant that there are groups, at the time of writing, attempting to have Back-to-Basics ideals legislated in some states. It is also noteworthy however that many educators in favour of the ideas expressed in the 1989 Standards described earlier, are voicing their disapproval of the Back-to-Basics movement.

Recommendations related to the use of technology

Recommendations for the use of technologies in school mathematics programs have been made in professional documents in many countries since the mid-1970s (see for example Australian Association of Mathematics Teachers & Curriculum Development Centre, 1987; Australian Education Council, 1991; Cockcroft, 1982; Davis, Maher & Noddings, 1990a; Her Majesty’s Inspectorate, 1992; National Council of Teachers of Mathematics, 1974, 1989; National Research Council, 1989).

In Australia, A National Statement on the Use of Calculators for Mathematics In Australian Schools, was published in 1987 (Australian Association of Mathematics Teachers & Curriculum Development Centre, 1987). It recommended the use of calculators by all students at all year levels, and it encouraged teachers to ensure their use both as instructional aids and as computational tools in the learning process. The Statement also explicitly encouraged teachers to “be actively involved in the curriculum change in content and methods arising from calculator use, [and to] take full advantage of the potential of calculators for mathematics within the total curriculum” (Australian Association of Mathematics Teachers & Curriculum Development Centre, 1987, p.1). Similar recommendations related to calculator use were made in the United States and the United Kingdom (see for example National Council of Teachers of Mathematics, 1974; National Research Council, 1989; Cockcroft, 1982; Shuard, 1986, 1992).

The publication and acceptance of policies and statements related to the use of computers in school mathematics programs appear to have drawn less attention than those related to calculator use. Whilst the implementation of calculators in school programs has been quite controversial, the acceptance of computer technology as a necessary part of school programs has been noticeably resistance free. In Australia, no specific policy has been documented related to the use of computers in school
mathematics programs, however reference to their use has been made in *A National Statement on Mathematics For Australian Schools* (Australian Education Council, 1991), as well as policy and curriculum documents prepared at State and local levels. Similar references to their use have been made in reports and curriculum documents in the United Kingdom and the United States (see National Council of Teachers of Mathematics, 1989; Shuard, 1986).

**Recommendations related to the teaching, learning and assessment of mathematics**

Whilst they have been expressed in different ways, recommendations related to the teaching, learning and assessment of mathematics across Australia, the United States and the United Kingdom have a high level of consistency in meaning and intent, with most of them based on constructivist epistemologies described previously.

Recommendations published as early as 1982 in the landmark report of Cockcroft in the United Kingdom, emphasised the need for students to be engaged in the practical exploration of mathematics with a focus on developing students' understanding of mathematical ideas and actions. In contrast to traditional mathematics programs that were primarily focused on mathematical content, the Cockcroft report emphasised the importance of also developing the processes of mathematical thinking. It recommended that mathematical understanding be attained through practical work and problem solving and investigation, and it noted the central role of language in the teaching and learning of mathematics. Furthermore it urged teachers to seek a balance between six elements of successful mathematics teaching: exposition; discussion; practical work; practice of skills and routines; problem solving; and investigation (Cockcroft, 1982). As mentioned previously, the publication of the *National Curriculum for England and Wales* (Department of Education and Science and the Welsh Office, 1989), with its specific focus on the achievement of skills, has since however discouraged many teachers in those countries from exploring new approaches to teaching mathematics (Burton, 1996).

In the United States, the National Research Council (1989) stated:

> Research on learning shows that most students cannot learn mathematics effectively by only listening and imitating; yet most teachers teach mathematics just this way, ... Research in learning shows that students actually construct their own understanding based on new experiences that enlarge their intellectual framework in which ideas can be created. Consequently, each individual's knowledge of mathematics is uniquely personal. Mathematics becomes useful to a student only when it has been developed through a personal intellectual engagement that creates new understanding. (p. 6)
Specific recommendations related to the teaching and learning of mathematics have been documented in the publication *Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics, 1991a). This document provides a set of principles intended to support teachers in working towards the vision of the reformed mathematics classroom articulated in the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989). Together these documents were intended to establish a broad framework to guide change in school mathematics in the United States. The NCTM outlined five major shifts in the environment of mathematics classrooms needed “to move from current practice to mathematics teaching for the empowerment of students” (p. 3). They reported that shifts were needed:

- toward classrooms as mathematical communities—away from classrooms as simply a collection of individuals;
- toward logic and mathematical evidence as verification—away from the teacher as the sole authority for right answers;
- toward mathematical reasoning—away from merely memorizing procedures;
- toward conjecturing, inventing, and problem solving—away from an emphasis on mechanistic answer-finding;
- toward connecting mathematics, its ideas, and its applications—away from treating mathematics as a body of isolated concepts and procedures. (p.3)

In Australia, the *National Statement on Mathematics for Australian Schools* (Australian Education Council, 1991) described a number of learning principles and consequent implications for teaching based on the proposition that “learning is best thought of as an active and productive process on the part of the learner”. These were:

*Learning principles*

- Learners construct their own meanings from, and for, the ideas, objects and events which they experience
- Learning happens when existing conceptions are challenged
- Learning requires action and reflection on the part of the learner
- Learning involves taking risks

*Implications for teaching*

- Mathematics learning is likely to be enhanced by activities which build upon and respect students’ experiences
- Mathematics learning is likely to be enhanced by activities which the learner regards as purposeful and interesting
- Mathematics learning is likely to be enhanced by feedback
- Mathematics learning is likely to be enhanced by using and developing appropriate language
- Mathematics learning is likely to be enhanced by challenge within a supportive framework

(Chapter 3)
These principles of learning and implications for teaching, together with those recommended in the United States and the United Kingdom, represent significantly different models of mathematics learning and teaching from those experienced in traditional classrooms. In contrast to learners being compliant receivers of mathematical knowledge in traditional classrooms, the changed vision for the role of students sees them actively involved in making sense of mathematics through exploring and engaging in mathematical tasks. A similar shift in the role of teachers is evident. Whereas exposition and demonstration of prescribed content was emphasised in traditional classrooms, it has been recommended that teachers select from an extended repertoire of teaching strategies those they consider most appropriate for a particular context (mathematical content focus; student group; setting; available resources etc.). It has also been recommended that the teacher’s role involve selecting problems, modelling mathematical actions, coaching student thinking, posing questions and stimulating and moderating classroom discourse. Recommendations made in documents published in the late 1980s and early 1990s signal a shift from teaching methods that emphasise the procedural learning of mathematics content to those that encourage reasoning and understanding.

Recommendations for changes in the methods used to assess students’ mathematics learning have also been made. D.J. Clarke (1996) synthesised the research literature related to new approaches to assessment. He concluded that contemporary mathematics assessment tasks are characterised by:

• their “contextualized” nature;
• their open-endedness;
• the anticipation of multiple solutions; and
• the requirement that students evaluate the appropriateness of different solutions. (p. 341)

The use of these types of assessment tools would be in keeping with approaches to teaching and learning based on the constructivist perspective discussed earlier.

In Australia, the publication of a national statement on mathematics education by the Australian Education Council in 1991, led to the development four years later of a national mathematics curriculum profile (Curriculum Corporation, 1994). As with other national initiatives, the profiles document served as a guideline to education authorities in each state, who have either adopted or adapted it to match their state’s curricular priorities. The profiles initiative has led to a significant shift in the way the mathematics curriculum is specified in Australia. The curriculum is now defined in terms of learning outcomes rather than mathematical topics, and student performance related to the achievement of the specified learning outcomes which are clustered into
levels, is progressively monitored, rather than graded. Whilst this initiative was aimed at providing a nationally consistent structure for monitoring and communicating student performance (Board of Studies, 1995; D.J. Clarke, 1996), some members of the education community have expressed concern related to the emphasis given to the prescriptive attainment of individual learning outcomes in some school programs, and in particular to the mandated implementation in some states of standardised testing (for example in Victoria, the Learning Assessment Program [LAP]) and benchmarking programs.

In the United States, the reconceptualisation of the mathematics curriculum documented in the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989), demanded a new vision of assessment. The publication of the *Assessment Standards for School Mathematics* (National Council of Teachers of Mathematics, 1995) provided details related to that new vision. Six standards for the assessment of school mathematics were identified by the NCTM. Table 2.6 provides a summary of the six standards. The implementation of these Assessment Standards varies, with some states mandating particular assessment tasks and others assessing student performance at local or district levels.

<table>
<thead>
<tr>
<th>STANDARD</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Mathematics Standard</td>
<td>Assessment should reflect the mathematics that all students need to know and be able to do</td>
</tr>
<tr>
<td>The Learning Standard</td>
<td>Assessment should enhance mathematics learning</td>
</tr>
<tr>
<td>The Equity Standard</td>
<td>Assessment should promote equity</td>
</tr>
<tr>
<td>The Openness Standard</td>
<td>Assessment should be an open process</td>
</tr>
<tr>
<td>The Inferences Standard</td>
<td>Assessment should promote valid inferences about mathematics learning</td>
</tr>
<tr>
<td>The Coherence Standard</td>
<td>Assessment should be a coherent process</td>
</tr>
</tbody>
</table>

As mentioned earlier, since the publication of the *National Curriculum for England and Wales*, assessment practices in those countries have been dominated by prescriptive skills testing in response to the mandated testing programs being implemented there.
Whilst many recommendations have been made to accompany curriculum change with change in assessment practices, Cooney (1994) reported that changes to assessment practices at the classroom level are in their "infancy at best" (p. 17). He conducted a study of the assessment practices of secondary teachers in the United States, which involved a survey of 201 teachers, a questionnaire to 102 of those teachers, and later interviews with 18 of the teachers in a final group (Cooney, 1992). He found that many teachers regarded computational tasks as suitable for determining "deep and thorough understanding" of topics (p. 17). Results of the teacher interviews suggested that several teachers had a reductionist perspective both to mathematics as a subject and to the assessment of mathematics learning. As Cooney noted, "Such a perspective almost certainly excludes outcomes involving significant experiences in problem-solving, communication, or reasoning" (p. 17), such as those described in recent curriculum documents. As an outcome of the study, Cooney suggested that if change in mathematics education is to become a reality, assessment should be given considerable attention in professional development programs (p. 18).

**Recommendations related to mathematics education and change**

In addition to the articulation of changes needed in relation to the content of the mathematics curriculum, the use of technology, and methods used for the teaching, learning and assessment of mathematics, recommendations related to the need for change itself to be regarded as a natural and expected part of the process of mathematics education have been consistently documented in the literature. As stated by the National Research Council (1989):

> Change is a natural state for education, not just a transition between old and new. To ensure continuous responsiveness in the future, mathematics education must adopt structures that will make change permanent; mathematics education must always respond to changes in science, in society, and in mathematics itself. (p. 73)

There appears common agreement amongst educators that the precise nature of people's future mathematical needs is unknown (Australian Education Council, 1991; Kaput, 1992; National Council of Teachers of Mathematics, 1989; National Research Council, 1989; Shuard, 1986). An implication of this is that mathematics education needs to focus not just on teaching students mathematics, but also on teaching them how to learn about mathematics. Shuard (1986) surmised:

> The curriculum of primary mathematics needs to change in a number of ways. It does not take sufficient account of how children learn, nor does it take sufficient account of changes in technology. But more importantly, it does not take sufficient account of the need to prepare
children to live in a continually changing world, and to face the challenges of change. (p. 133)

Attempts to address the challenges of change that Shuard referred to can be observed in the recommendations for change in mathematics education discussed throughout this section. Many of the recommended changes to the content and emphases of the mathematics curriculum, the use of technology, and methods of mathematics teaching, learning and assessment, have been purposefully focused on developing in students the ability to be effective learners of mathematics.

A further area of significant agreement amongst those responsible for change in mathematics education relates to the important role teachers are expected to play in the realisation of change recommendations. Unlike previous change efforts where curriculum documents and texts were viewed as the vehicles to realise change, recent efforts have been purposefully focused on the mathematics teaching profession (National Council of Teachers of Mathematics, 1991a). Attempts to inform the teaching profession of the mathematics education change agenda and to encourage and support them in effecting improvement in mathematics teaching and learning have been made in each of the countries discussed in this section. The professional development of mathematics teachers is seen as critical to the improvement of mathematics education. As Shaw and Jakubowski (1991) reported, "the effectiveness of mathematics education reform is only as good as the commitment and willingness of teachers to change" (p. 20). Avenues of change for mathematics teachers are discussed next.

### 2.2.2 Avenues of change for mathematics teachers

An examination of the research literature related to teacher change in the context of mathematics education identified four different ways mathematics teachers might engage in change: through individual professional activity; through research projects; through school-based efforts to change; and through organised professional development activities. This section provides examples of each of these to present an image of the research that has been completed related to mathematics teachers and change.
Individual professional activity

As teachers engage in the act of teaching, opportunities exist to use classrooms as sites for their own professional learning, where they can experiment with different teaching approaches and critically reflect on those approaches. Etchberger and Shaw (1992) conducted a case study of a fifth-grade teacher who changed her teaching approach from individual teacher-dispensed mathematics to cooperative teacher-assisted mathematics. Following an analysis of classroom observations, interviews, and a reflective journal completed by the teacher over a four month period, Etchberger and Shaw found that the project teacher felt perturbed by a dissatisfaction in her students' learning of mathematics, particularly as she reflected on the success they were experiencing in learning science with meaning in her classroom. They reported that the teacher's reflection led her to consider making changes in her mathematics teaching.

The process of reflecting on one's practice was earlier identified by Shaw, Davis, Sidani-Tabbaa and McCarty (1990), and Jakubowski and Tobin (1991) as one of the six interrelated cognitive requisites in the change process. They suggested that for change to occur teachers needed to:

- experience a perturbation;
- develop an awareness of a need to change;
- make a commitment to change;
- construct a vision of what is involved in the change;
- project themselves into that vision; and
- continually reflect on their practice.

In their study, Etchberger and Shaw (1992) identified teacher reflection as a key to continued change. They reported that the project teacher "changed her entire concept of teaching and learning by reflecting on how students learn" (p. 416), and they concluded that "reflections, when acted upon, generated powerful transformations" (p. 416). They also stated that for the teacher in their project change "was an evolutionary process; one that is continuing" (p. 416). The notion of change as an ongoing process, which was discussed earlier in this chapter, is one that pervades the findings of many of the researchers discussed throughout this section.

Research projects

In some research projects, teachers are directly encouraged to engage in change proposals. One such project related to change in mathematics teaching and learning
was conducted by Wood, Cobb and Yackel (1991). Their study investigated individual children’s construction of mathematical knowledge. Extending the methodology of the teaching experiment conducted by Cobb and Steffe (1983), they developed a set of problem-centred instructional activities and methods of classroom organisation related to constructivist assumptions, for application in a second grade classroom. Their intention was to video record each mathematics lesson in the second grade class for one year and analyse the process of mathematical meaning making by students. As the project developed however, it became apparent that the classroom they were investigating was a setting in which the teacher was also learning:

In the process of creating environments for children to learn mathematics with meaning, we became aware that the classroom had simultaneously and unintentionally become a learning environment for the teacher as well. As the project teacher used the instructional activities we had developed, interacted with her students, and engaged in communicative discourse, she encountered situations that were in sharp contrast to her previous experiences in teaching mathematics. These contradictions created conflicts, dilemmas, and surprises that in turn proved to be learning opportunities for her as well as the students. In the process of resolving these contradictions, she developed a form of practice compatible with constructivism in which her beliefs about her role, the student’s role, and the nature of mathematics changed dramatically. (p. 588)

This led to their study being expanded to include analyses of situations in which opportunities for the teacher to learn occurred. Data collected in the form of field notes during mathematics lessons and project meetings, open-ended interviews, and lesson observations and video recordings, provided information about the teacher’s thinking and practice.

A significant outcome of Wood, Cobb and Yackel’s (1991) analysis was the crucial importance of the classroom as an environment for both teacher and student learning. They reported that:

In order for teachers to change their practice, opportunities must exist for them to learn in the setting of their classroom as they are involved in the learning of their students. (p. 611)

They further highlighted the importance of reflection and collaboration throughout the process of change. In seeking to resolve contradictions with her traditional practice, the teacher involved in Wood, Cobb and Yackel’s project sought opportunities to reflect on her teaching, and to express concerns and receive suggestions from the researchers. This interaction with the researcher constituted a basis for communication about children’s learning of mathematics and supported the teacher in her
reorganisation of her thinking about teaching, learning and mathematics. Wood, Cobb and Yackel (1991) outlined the implications of their findings for change in mathematics education as follows:

It is important for those involved in teacher development and school reform to realize that a challenge exists if reform in elementary-school mathematics education is to be successful. This challenge relates to the needs of classroom teachers as they encounter a different emphasis in the goals of mathematics education and children's learning that, for most, requires a substantial change in the way they teach mathematics. If teachers are going to make drastic changes in their ways of teaching, they will need continued support as they encounter dilemmas and conflicts. This means finding ways to guide and support teachers as they learn in the setting of their classroom; these ways are fundamentally different from past attempts or traditional procedures. (p. 611)

The ideas of Wood, Cobb and Yackel related to classrooms as environments for teacher learning (Cobb, Wood & Yackel, 1990; Cobb, Yackel & Wood, 1992; Wood, Cobb & Yackel, 1991), provided the impetus for a study of teacher change by Boufi (1994). She investigated the process of change for a first-grade teacher who attempted to develop a form of practice compatible with socioconstructivist views of learning. Over an extended period of time, Boufi and colleagues videotaped most of the teacher's lessons, observed two classroom lessons each week, and had weekly discussions with the teacher. Through this process they were able to support the teacher in her efforts as they collaborated with her, and at the same time study her process of learning. Boufi described three teaching episodes illustrative of the teacher's development across the time of the study. She reported significant changes in the teacher's practice in the course of her interactions with the students and her interactions with the researchers. Specifically, Boufi noted:

Her classroom experiences have persuaded her that students can share a part of the responsibility for their learning. As a consequence, her views about her own role as a teacher have also changed. Mathematics is not any more the subject with the fixed answers. As she works with her students, she experiences a way of doing mathematics much more different than the one she used to. The textbook ceased to be the source of her teaching. In our meetings, she was increasingly involved in the development of instructional activities. (p. 125)

Boufi (1994) concluded that changes in the teacher's beliefs appeared to be reflexively related to changes in her practice.
School-based efforts

A further way in which teachers become involved in changing their practice is through school-based change efforts. Proposals for change at the school level can be made by whole schools, faculties, departments, or collegial groups interested and committed to change.

Brosnan, Edwards and Erickson (1996) conducted a two-year study in one school setting to examine changes in teachers’ beliefs and practices as they were involved in a transition from traditional practices to a closer approximation of mathematics programs that reflected the NCTM’s Standards. The school selected for study was in its fourth year of a comprehensive restructuring program, and the sixth grade teachers who were the focus of this study had worked on developing a strong literacy program over the previous three years, and sought university assistance to reform their mathematics teaching.

Two key study phases were developed and implemented. In the first “planning” year, a shared vision of what sixth grade mathematics should comprise was developed through a variety of professional activities including: self-assessments; visits to exemplary schools; attending conferences and meetings; participating in inservices; designing a summer teaching institute; reading literature; and purchasing appropriate references and resources. In the second “implementation” year, four teachers who volunteered to teach mathematics full time were paired with graduate students from the university, who provided assistance and support in implementing the new curriculum for two days per week.

Data from interviews, observations, journals, surveys, and video recordings were used to develop case studies of the four teachers which were analysed individually and across cases. Brosnan, Edwards and Erickson (1996) found evidence of change in the practice of the four teachers in relation to “a decrease in the teaching of procedures and assigning drill and practice work and an increase in the use of student-centred activities, manipulatives and calculators” (p. 50). They also reported “increases in small group work, student communication of mathematical ideas, and the use of alternative assessment such as observations, student projects, journals, and portfolios” (p. 50).

Brosnan, Edwards and Erickson (1996) outlined several key findings related to the process of change as teachers attempted to implement recommendations made in the
NCTM Standards. Like Etchberger and Shaw (1992), Brosnan, Edwards and Erickson found that the teachers in their study were motivated to change through a dissatisfaction with what they were teaching and how they were teaching. They also found that teachers were encouraged to continue their change efforts by the positive responses of their students to the new ideas. Brosnan, Edwards and Erickson (1996) identified a number of factors that supported teachers in the process of change, including: collegial and administrative support during implementation; inservice opportunities; resource purchasing; and participation in their study. They also reported hindrances to change identified by the teachers in their study. These included: limited knowledge of mathematical content, methods and evaluation techniques; limited organisational strategies; and difficulties in documenting student progress to usefully inform assessment and instructional decisions.

Brosnan, Edwards and Erickson (1996) outlined several implications of the results of their study for the design of professional development programs and more generally for effecting teacher change. They suggested that professional development activities should:

- begin with specific, practical ideas for classroom use;
- include learning theory and demonstrations;
- focus on the organisation and prioritising of content;
- provide ideas about classroom organisation, lesson planning and evaluation; and
- focus on alternative assessment practices.

They further suggested that:

Districts interested in making changes should attempt implementation slowly by first identifying a few interested teachers to pilot the innovation, supporting those teachers in significant ways, and providing for long-term commitment to change through professional development. Successes may then be shared to encourage the participation of other teachers. Support for interested teachers might include shifting monies from buying workbooks to buying student-centred activity books, providing financial support for teachers to attend professional conferences, inservice programs, or adjust schedules so that interested teachers might meet during school hours to discuss mutual concerns. (p. 51)

D.J. Clarke, Carlin and Peter (1992) conducted a study of the process of change for teacher participants of a professional development program titled "Active and Reflective Teaching in Secondary Mathematics" (ARTISM). The ARTISM program arose from the efforts of a group of teachers from one secondary school undertaking a curriculum review. The program was developed between three collaborative groups: teachers; the school system (Catholic Education Office of Victoria); and a tertiary
institutions (Australian Catholic University). It comprised five workshop units and
school visits by consultants between units, and was intended to make teachers aware
of current developments in the teaching and learning of mathematics and to encourage
them to explore new techniques in their classrooms. Thirty three teachers from three
schools participated.

D.J. Clarke, Carlin and Peter (1992) reported that the ARTISM program led to changes
in teachers' classroom practices and they identified seven elements of the professional
development program as key factors in facilitating teacher change:

- the conscious recognition of the classroom consequences of
  contemporary theory;
- the extended nature of the ARTISM program;
- the collaboration between developers, consultants and
  participant schools;
- the support and accountability provided by the school visits;
- the participation of a substantial number of mathematics
  teachers from each school;
- the practical nature of the program's work requirements;
- the emphasis given to teacher reflection on classroom practice
  (p. 30).

Many of these elements find support in the work of other researchers. For example, as
discussed earlier, the importance of teacher reflection in the process of change was
highlighted by Etchberger and Shaw (1992) and Wood, Cobb and Yackel (1991), and
the importance of collegial support was recognised by Brosnan, Edwards and Erickson
(1996). Similarities can also be noted in D.M. Clarke's (1994) list of ten key principles
for the professional development of mathematics teachers extracted from the research
literature (previously listed on p. 26). The work of D.M. Clarke (1997), Knapp and
Peterson (1995), and Becker and Pence (1996), to be discussed in the next section, has
substantiated many of these principles.

Organised professional development programs

Organised professional development activities have become a major vehicle for change
in mathematics education. Often developed and implemented at state or district
levels, and supported through a range of funding sources, they vary considerably in
design, scope and intended outcomes. Researchers including D.M. Clarke (1997),
and Herrera (1996) have investigated the process of change for mathematics teachers
involved in professional development activities.
D.M. Clarke (1993, 1997) studied the changing teacher roles associated with two Year 6 teachers' use of innovative mathematics curriculum materials. The teachers involved in D.M. Clarke's study participated in a professional development program with 30 other teachers, part of which involved the teaching of a six-week measurement unit from the Mathematics In Context (MIC) project, a curriculum development project funded by the National Science Foundation and based at the University of Wisconsin—Madison. The professional development program consisted of four workshop sessions; two to introduce the philosophy and content of the project, one to focus on assessment alternatives for the unit, and a final session to review the teaching of the unit. Weekly visits from a project staff member were also made while the teachers taught the unit.

D.M. Clarke used classroom observations and interviews with the teachers throughout the teaching of the unit to build a picture of the process of change in their roles and their perceptions of their roles. D.M. Clarke (1997) reported that whilst the two teachers involved in his study had similar teaching backgrounds, worked in the same school and grade level, planned together, team-taught together, had students allocated to them in the same way, and had similar ongoing support throughout the study, their experiences of the professional development program and the process of change were quite different. One teacher, changed his practice significantly, whilst changes in the practice of the other teacher were less apparent. In discussing possible reasons for these differences, including personal factors, teacher content knowledge, class composition and organisational arrangements, D.M. Clarke highlighted the highly personal nature of change and the need to be considerate of such factors when comparing teachers involved in change. He also concluded that the lack of growth of one of the teachers "points out that nothing can be guaranteed, even when many factors supporting professional growth are present" (p. 305).

Some of D.M. Clarke's (1997) findings supported the findings of researchers discussed earlier. For example, the importance of teacher reflection and the need for support and collaboration during the process of change were both confirmed in D.M. Clarke's data. Other findings were challenged. D.M. Clarke, for example, found that teachers do not necessarily need to regard their current practice as problematic (Wood, Cobb & Yackel, 1991) prior to being encouraged to explore different teaching approaches. It was only after one teacher in D.M. Clarke's study began to explore new approaches with his students, that he considered previous methods problematic. Two further findings made by D.M. Clarke were: the provision of innovative curriculum materials appears
to encourage and support teachers in the process of change, and a lack of teacher content knowledge appears to negatively influence teachers’ abilities to change.

Knapp and Peterson (1995) conducted a follow-up study to seek teachers’ interpretations of a Cognitively Guided Instruction (CGI) inservice four years after it was conducted. Participants in the month-long CGI inservice were not “trained”, but rather were introduced to new ways of thinking about mathematics learning and teaching through looking at findings from a previous study of children’s methods and strategies, and considering theoretical frameworks derived from that study. By viewing original videotapes of the children at work, and discussing and debating the findings, teachers were able to determine with the researchers how the knowledge might be useful in the unique context of their own classroom practice. Knapp and Peterson conducted one-hour telephone interviews with 20 teachers involved in either the 1986 or 1987 CGI inservice groups. They identified three different groups of teachers with regard to CGI use: those who continued to use CGI as the main basis for their teaching; those who never used CGI more than supplementally or occasionally; and those who reported using CGI soon after the inservice but who used it infrequently at the time of the study. Knapp and Peterson reported that one element crucial to the continued implementation of innovative ideas identified by teachers was “ongoing conversation and interaction with other teachers” (p. 60). Significantly, 18 out of 20 teachers interviewed reported the continuing opportunity to interact with others who were trying to use the ideas presented in the inservice as vital to their development and change. Knapp and Peterson highlighted the gradual nature of change stating that “even a month long workshop is only the beginning of a process that requires continuing effort and support over a number of years” (p. 60).

The need for professional development activities that provide opportunities for teachers to engage in extended conversation about mathematics teaching and learning was also emphasised in the work of Becker and Pence (1996). They investigated the involvement of secondary teachers in two ongoing professional development projects, the “Building Bridges to Mathematics for All” project, and the “San Jose Mathematics Leadership Project” (Becker & Pence, 1996). Becker and Pence stated that their research program substantiated many of D.M. Clarke’s (1994) ten principles for the professional development of mathematics teachers outlined earlier. In particular, Becker and Pence noted the importance of involving groups of teachers in professional development over extended periods of time. They also concluded that “a support network is essential for ongoing professional development to occur” (p. 115).
The importance of collaboration throughout the process of change was further highlighted by Shaw and Jakubowski (1991). They described case studies of three teachers as they reacted to perturbations that arose through professional development activities. They found two important elements that contribute to worthwhile change. The first related to collaboration with colleagues similarly perturbed and interested in changing. Shaw and Jakubowski stated that such collaboration provided a significant and important support system for individuals involved in change. The second element, closely associated with collaboration, involved “having access to alternative images to implement one’s vision [of change]” (p. 19). From their ongoing research on teacher change, Shaw and Jakubowski have become convinced that:

Teachers will not change unless they are perturbed in some substantial way; they will not change if they are perturbed, but are not willing or committed to change; they will not change if they are perturbed, are willing to change, but lack alternative approaches to teaching and learning; and they may not change if they are perturbed, willing to change, have the necessary alternatives, but lack the benefits of support and collaboration. (p. 20)

Herrera (1996) highlighted the important part that teachers’ prior perceptions play in their response to innovations. She conducted case studies of three teachers from varying backgrounds and school locations who were participants in Project Discovery, a statewide initiative sponsored by the National Science Foundation and the State of Ohio. Focused on the inquiry method of instruction, Project Discovery was a long-term mathematics inservice which included a six-week summer institute and several follow-up seminars. The summer institute placed the participants in a learning environment where the instructional philosophy of the project (shaped by constructivist theory) was modelled. Herrera reported that teachers’ conceptions of mathematics, of inservices, and of teaching, affected the way in which they responded to the ideas presented to them during the inservice. She noted that teachers selected ideas congruent with their prior conceptions to insert into existing practice, and that their conceptions mediated new materials as they strived to maintain intact their personal interpretations of mathematics teaching and to fulfil their perceived primary responsibility of covering the official curriculum. Herrera concluded that:

Given the power and persistence of prior conceptions (Duffy & Roehler, 1986; Wallace & Louden, 1992), those involved in mathematics reform need to address the various sources of dissonance between established teacher practices and innovative methods, especially those created by incongruent mathematics philosophies. Otherwise, those conceptions that underlie existing practice can lead to a re-shaping of an innovative program into a format that aligns more comfortably with the status quo and can inadvertently sabotage teacher change. (p. 80)
2.2.3 Overview of key findings

The studies of teacher change discussed in the previous section were varied in their design, scope, and specific outcomes. As displayed in Table 2.7, the studies represent individual teachers' attempts to change, change initiated through research projects, school-based change efforts, and change initiated through organised professional development (PD) activities. They represent different research types, including case study, survey, program evaluation, and in one case, a "variety of quantitative and qualitative approaches" (Becker & Pence, 1996, p. 103). The studies also focus on different school levels, vary in the number of participants involved, and vary in duration.

Whilst differences between the studies were evident, a number of key findings related to the process of change and characteristics of professional development activities emerged. These include:

- recognition of the classroom as an environment for both teacher and student learning;
- the importance of teacher reflection;
- the importance of collaboration between teachers;
- the importance of collegial and administrative support;
- the importance of in-depth and ongoing professional development activities;
- the importance of environments supportive of professional growth;
- recognition that change is a gradual and complex process; and
- recognition of possible impediments to change for mathematics teachers.

Consistency between many of these findings and those presented in the earlier discussion of the teacher change and teacher professional development literature can be noted. The next section describes the directions for this study arising from the research literature.
Table 2.7
Overview of Characteristics of the Studies Discussed in Section 2.2.2

<table>
<thead>
<tr>
<th>AVENUE OF CHANGE</th>
<th>STUDY</th>
<th>STUDY TYPE</th>
<th>LENGTH OF STUDY</th>
<th>SCHOOL LEVEL</th>
<th>NUMBER OF TEACHERS</th>
<th>PD ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDIVIDUAL ACTIVITY</td>
<td>Etchberger &amp; Shaw (1992)</td>
<td>Case Study</td>
<td>4 months</td>
<td>Primary (Grade 5)</td>
<td>1</td>
<td>No PD activity</td>
</tr>
<tr>
<td>RESEARCH PROJECT</td>
<td>Wood, Cobb &amp; Yackel (1991)</td>
<td>Case Study</td>
<td>1 year</td>
<td>Primary (Grade 2)</td>
<td>1</td>
<td>No PD activity</td>
</tr>
<tr>
<td></td>
<td>Boufi (1994)</td>
<td>Case Study</td>
<td>6 months</td>
<td>Primary (Grade 1)</td>
<td>1</td>
<td>Initial seminar (followed by research project)</td>
</tr>
<tr>
<td>SCHOOL-BASED EFFORT</td>
<td>D.J. Clarke, Carlin &amp; Peter (1992)</td>
<td>Program Evaluation and Case Study</td>
<td>18 months</td>
<td>Secondary (Grades 7 to 10)</td>
<td>Program Evaluation: 33 Case study: 1</td>
<td>Customised staff development project: 2 school terms</td>
</tr>
<tr>
<td></td>
<td>Brosnan, Edwards &amp; Erickson (1996)</td>
<td>Case study</td>
<td>2 years</td>
<td>Primary (Grade 6)</td>
<td>4</td>
<td>Customised summer intensive inservice (length not reported)</td>
</tr>
<tr>
<td>ORGANISED PD PROGRAM</td>
<td>Shaw &amp; Jakubowski (1991)</td>
<td>Multiple Case Studies</td>
<td>a) 2 years b) 1 month c) 1 month</td>
<td>a) Primary (Grade 2) b) Primary (Grade 5) c)Secondary (Grade 6)</td>
<td>a) 1 b) 1 c) 1</td>
<td>a) Staff development project: 2 years b) Inservice class: 1 session c) Inservice class: 1 session</td>
</tr>
<tr>
<td></td>
<td>Knapp &amp; Peterson (1995)</td>
<td>Survey</td>
<td>Inadequate information available [1 hour interviews conducted 3–4 years after pd]</td>
<td>Primary (Grades 1 &amp; 2)</td>
<td>20</td>
<td>Summer intensive inservice: 1 month</td>
</tr>
<tr>
<td></td>
<td>Becker &amp; Pence (1996)</td>
<td>Multiple Methods - &quot;Variety of quantitative and qualitative approaches&quot; (p. 103)</td>
<td>2–3 years</td>
<td>Secondary (20 schools)</td>
<td>(20 schools)</td>
<td>a) Staff development project: 1 year b) Staff development project: 2 to 3 years</td>
</tr>
<tr>
<td></td>
<td>Herrera (1996)</td>
<td>Case Study</td>
<td>14 months</td>
<td>Primary &amp; Secondary (Grades 6 to 8)</td>
<td>3</td>
<td>Summer intensive inservice: 6 weeks</td>
</tr>
<tr>
<td></td>
<td>D.M. Clarke (1997)</td>
<td>Case Study</td>
<td>7 months</td>
<td>Primary (Grade 6)</td>
<td>2</td>
<td>Staff development project: 4 sessions plus additional support visits over 7 months</td>
</tr>
</tbody>
</table>
2.3 Directions for this study arising from the literature

2.3.1 Directions related to teacher change and effective professional development

The review of the literature related to teacher change and effective professional development highlighted:

- the complexity of teacher change (including the conditions needed for teachers to change); and
- the types of professional development programs that encourage and support teacher change.

Each of these factors has implications for the design of this study.

It seems appropriate that the complexity of change be acknowledged in any study of teacher change. The existing research literature raises the need for further longitudinal studies of change, and for studies that provide detailed descriptions of the processes associated with change and growth. These needs provided specific directions for the design of this study, including the development of rich descriptions of teacher professional growth over an extended period, and the use of a theoretical model of appropriate complexity to represent change and growth.

It also seems appropriate that studies of change focus on professional development programs that have features consistent with the principles of effective professional development grounded in the literature. In this way, better understandings of the processes associated with growth in such contexts can be determined. This needs to be considered when selecting professional development programs to investigate teacher professional growth.

2.3.2 Directions related to teacher change and mathematics education

The climate of change experienced in mathematics education from the early 1980s to the mid 1990s invoked many challenges and demands on the mathematics teaching profession. Changes were recommended for the improvement of mathematics teaching and learning in areas of curriculum content and pedagogy, and, significantly, it was proposed that these changes be realised through the agency of teachers. This marked a distinct shift in focus with respect to curriculum reform. In the past, many reform attempts had focused on the publication of curriculum documents with the
anticipation that these would provoke widespread change. However, in the period in which this study was conducted, teachers themselves were given direct responsibility for effecting change in mathematics education. Change pervaded the mathematics education community at the time when this study was initiated, and it seemed appropriate to make use of this context to learn more about the processes involved in teacher professional growth.

A variety of mathematics professional development programs were developed during the late 1980s and early 1990s. These programs provided one forum to encourage the professional growth of teachers of mathematics, and, consequently, they provided appropriate contexts to research teacher growth. It was envisaged that a longitudinal study related to primary teachers involved in mathematics professional development would usefully extend the work of other researchers who have focused on teacher change in the context of organised professional development programs (see, for example, Table 2.7).

The following chapter outlines the research approach and describes the professional development program through which this study of teacher professional growth was undertaken.
Chapter 3
Research approach, setting and outline

This chapter describes the research approach, setting, and procedure of this study. First, the selection of the research approach is described and justified—in particular the choice of case study. Second, the setting for the study is discussed. Considerations related to the selection of the setting, and a description of the professional development program used as the vehicle for investigating teacher growth in this study are provided. The final section of this chapter outlines the study procedure. In particular it describes the two phase structure of the study and the timeframe of the research.

3.1 Selecting a research approach

3.1.1 Factors influencing the selection of a research approach

The selection of a research approach for this study was influenced by three factors: the purpose of the study; my assumptions about knowledge; and the opportunities and constraints with which I was confronted. A discussion of each of these factors follows.

Purpose of the study

Patton (1990) reported:

> Purpose is the controlling force in research. Decisions about design, measurement, analysis and reporting all flow from purpose. 
> (Patton, 1990, p. 150)

In line with Patton’s view of purpose as the controlling force in research, the considerations made in this study with respect to selecting a research approach were directly related to the research purpose.

The major question addressed by this study is:

Can professional development programs act as appropriate vehicles for effecting the professional growth of teachers of primary mathematics?
This focus on teacher growth in the context of professional development related to mathematics education developed out of my work-related interests, my initial review of the research literature, and my adoption of a learning perspective on teacher change. In particular, I was interested in learning more about the processes associated with growth for primary teachers involved in mathematics professional development, and the factors that encouraged, supported, or inhibited growth.

To address this purpose, a research approach was needed that would enable the study of process—in particular, the process of teacher professional growth. Reasons for focusing on qualitative methods, and, in particular, for selecting case study as the approach for use in this study, are explicated in the sections that follow.

**Assumptions about knowledge**

As I examined the literature related to different research approaches, I reflected on the paradigmatic perspective from which I would conduct the investigation in this study. I was not simply interested in labelling my research, but rather in focusing the "conceptual lens" through which I would view phenomena (Popkewitz, 1984).

I found four broad paradigms in the literature that were referred to with consistency, and that encompassed the plethora of research approaches that exist. These were: positivist (also referred to as empiricist); interpretivist; critical; and poststructuralist (also referred to as postmodernist and deconstructionist) paradigms. Many different interpretations of these paradigms exist and so a comprehensive description of each one is not attempted here. Rather an overview of each paradigm, synthesised from the work of Connole, Smith and Wiseman (1993), Locke (1988), and Neuman (1997), is provided to illuminate my association of this study with the interpretivist paradigm.

Fundamental to the positivist approach is the view that reality is unitary and that it "exists 'out there' waiting to be discovered" (Neuman, 1997, p. 64). Positivists therefore consider that the world can be objectively observed and measured using value-free methods to achieve generalisable laws. These "scientific" laws can then be used to predict and control future events.

In contrast to the positivist approach, the interpretivist approach is founded on the premise that reality "is intentionally created out of the purposeful actions of interacting beings" (Neuman, 1997, p. 69). Individual interpretations of reality are created through human interaction and therefore are fluid and multiple. Interpretive studies are inherently value-bound, emphasise social interactions, use various methods to determine meanings, and generate subjective, context specific knowledge.
While based on positivist ideas, the critical approach argues that social reality has many layers which evolve over time. Within this approach a difficulty associated with knowledge transfer is the potential for systematic distortion. The central concern of critical research is to "go beyond surface illusions to uncover the real structures in the material world in order to help people change [their] conditions" (Neuman, 1997, p. 74). Critical research is often described as political and emancipatory in nature, and transformative in endeavour.

As part of the larger postmodern movement, poststructuralist research approaches are also emancipatory in nature and share the criticalist goal of demystifying the social world. Poststructuralists view reality as accessible only through language as discourse. They challenge the foundations and frameworks of knowledge as truth by regarding realities simply as representations naturalised through ideology. Like critical research, poststructuralist approaches can be overtly political (Connole, Smith & Wiseman, 1993).

The interpretivist emphasis on meaning and social interaction captures the key aspects of this study. The social interaction of concern to this study occurs in two different but related settings—the professional development program and the classroom. My interest was in describing and interpreting the meanings participants constructed for themselves in relation to these settings, and in exploring the dynamics between these emergent meanings.

In the next section I describe the ways in which the opportunities and constraints that I was confronted with affected my choice of approach to use to explore, describe and interpret participants' meanings in this study.

*Opportunities and constraints arising from my professional activity*

My work context provided the impetus for this study, and as such, I considered it imperative that my research complement my professional activity. Two considerations emerged as important when selecting an appropriate research approach to complement my professional activity. First, the kinds of research approaches that I could reasonably engage in were limited. For example, given my role as a support person in schools, the conduct of an experimental study would have been ethically questionable. On the other hand, my close relationship with the teaching community provided the opportunity for fine-grained data collection about the practices and beliefs of individuals. Second, the workload and time demands of a part-time study alongside my full-time position as a curriculum consultant had to be considered. I therefore
sought a research approach that would enable me to collect data in a manner that was not foreign to, or obtrusive of, my work role. Specific reasons for the selection of case study as the approach for use in this study are provided next.

3.1.2 The choice of case study

The main focus of this study was on understanding the processes associated with teacher change and teacher growth, for teachers involved in professional development. Patton (1990) highlighted the suitability of qualitative methods for studying process:

Qualitative inquiry is highly appropriate in studying process because depicting process requires detailed description; the experiences of process typically varies for different people; process is fluid and dynamic; and participants' perceptions are a key process consideration. (p. 95)

In order to pursue my interest in process I considered that I would need to collect a range of data related to teachers' practice, their beliefs, and their views of the professional development program experienced. I also considered that the data would need to provide a "fine-grain" level of detail in order to explore these complex areas of teacher change and teacher growth. I selected case study as the broad approach for use in this investigation, as it would allow me to explore these areas with the "depth, detail and individual meaning" (Patton, 1990) which I required.

Stake (1995) distinguished two kinds of case studies: intrinsic, and instrumental. Intrinsic case studies are those in which there is an intrinsic interest in the case itself. Instrumental case studies are those where an issue is of more importance to the researcher than is the case. The main interest in this study was in learning about teacher change and teacher professional growth rather than the cases themselves; I therefore considered this to be an instrumental case study.

The particular design of this case study was informed by many factors:

- the research purpose, orientation, and the opportunities and constraints with which I was confronted, provided the initial impetus for the selection of case study as the broad approach to be used;
- the consideration of possible settings refined the focus on one professional development program;
- the examination of this professional development program led to the focus on specific teaching components to be explored, and consequently to the design of particular data collection tools and data analysis techniques; and
the use of a theoretical model to represent teacher change and teacher growth shaped the description and interpretation of the data collected.

In the following sections of this chapter, and in Chapters 4 and 5, the process of this case study design is elaborated.

3.1.3 Specific research questions

Two specific questions have been developed in order to investigate the major research question: can professional development programs act as appropriate vehicles for effecting the professional growth of teachers of primary mathematics? These are:

What change do primary teachers report and demonstrate in practice when they participate in a mathematics professional development program?

What factors associated with mathematics professional development programs do teachers perceive as influencing their professional growth?

In the next section a description is provided of the setting selected for investigating these questions.

3.2 Selecting a setting

3.2.1 A focus on one professional development program

Having chosen case study as the research approach, I then needed to select an appropriate context for the investigation of teacher change in this study. I decided to investigate six teachers involved in the same professional development program for two main reasons.

First, the investigation of a number of teachers would enable the observation and description of change specific to individual teachers, as well as contrasting change between teachers. I considered this to be important as these different perspectives could inform the development of a comprehensive picture of teacher change, and subsequently teacher growth.

Second, by investigating teachers involved in the same program, comparisons between cases could be made with some confidence because the professional development
experience was common to each of them. Had I addressed more than one professional development program any attempt to explain or compare the experiences of participants would have been very difficult.

In summary, my decision to focus the investigation of teacher development in this study on a number of participants from one professional development program was based on my view of the learning opportunity that context provided. As Stake (1995, p. 6) states, “opportunity to learn is of primary importance” in case study design. A description of the professional development program identified for use in this study is presented below.

3.2.2 The choice of the Victorian professional development program, Exploring Mathematics In Classrooms (EMIC)

The professional development program that I identified to serve as the vehicle for this study was the Victorian program, Exploring Mathematics In Classrooms (EMIC). The purpose of the EMIC program, which will be described in detail in the next section of this chapter, was to effect improvement in primary mathematics teaching by encouraging teachers to reflect on their own practice, consider new ideas in mathematics teaching and learning, and explore different teaching strategies in their classrooms.

The EMIC program comprised a series of ten workshops related to the teaching and learning of mathematics in primary schools. EMIC courses, which were conducted by trained tutors, involved groups of teacher participants from a number of schools in a local area or district. The course workshops were planned to run for two hours each, and were typically conducted after school hours either weekly or fortnightly. Teachers were expected to participate in each of the ten workshop sessions, complete professional readings related to each one, and complete classroom explorations related to the ideas presented. Program tutors provided support and feedback to participants between workshop sessions.

My decision to investigate teacher development in the context of the EMIC program was to a large extent based on the program’s characteristics. EMIC possessed many positive characteristics linked with key findings from the research literature. In summary, it:

- addressed in its content recent pedagogical developments related to mathematics education;
• included in its aims a commitment to informing and supporting teachers undergoing change;
• focused on teachers as learners;
• catered for varied teacher needs, interests and backgrounds;
• addressed in its design and implementation conditions needed for teachers to learn and implement new teaching strategies repertoire; and
• included in its aims a commitment to engage school level support and encourage collegiality.

The detailed description of EMIC provided in the next section will demonstrate how each of these characteristics was evident in the program. I considered that the EMIC program would be an ideal vehicle through which to investigate the research questions that guided the investigation in this study. In particular, I thought that an investigation of the ways in which teachers develop professionally when they participate in EMIC, and an investigation of the characteristics of EMIC that appear to influence teacher change, would provide useful insights into the broader research issue, that is the extent to which change in mathematics education can be achieved through teacher involvement in professional development.

Other considerations related to the identification of EMIC as an appropriate program for use in this study included:
• the program was accessible—at the time this study commenced, EMIC courses were being conducted on a regular basis throughout Victoria, thus access to an appropriate course was possible;
• it was locally developed and conducted—ready access to program documents and informants was available (this was particularly important to the design and implementation of the study, as will be reported in Chapter 4); and
• I was familiar with the program—as a trained EMIC tutor I had conducted several EMIC courses; it seemed logical and practical to make use of this in-depth knowledge of the program in this research context.

3.2.3 Description of EMIC

Background note

The EMIC program was initially developed and trialed from 1985 to 1987 and the program materials were first published in 1988. It was then revised in 1989 and
republished in 1990. While the overall aims and structure of the program remained the same, some changes were made to the program contents. A discussion of the background to the development of EMIC is presented in Chapter 4.

The EMIC course investigated in this study was conducted in 1991, so the course tutor and participants used the revised version of the program materials (Ministry of Education, Victoria, 1990a; 1990b). References to the program materials throughout this chapter therefore relate to the revised version, unless otherwise stipulated.

Aims of the program

The overall purpose of the EMIC program was to improve the teaching and learning of mathematics in primary schools (Robinson, 1987). The program was concerned primarily with pedagogy. It involved teachers in reflecting on their practice, being introduced to new ideas related to mathematics teaching and learning, and exploring some of those ideas in the workplace.

The stated aims of the EMIC program were to give teachers the opportunity to:

- reflect on their current practice as teachers of mathematics;
- consider current developments in mathematics education;
- increase their awareness of how children learn mathematics;
- try out and consider adopting new teaching/learning strategies;
- investigate the role of parents in supporting children's mathematics development;
- share and work cooperatively together; and
- gain confidence as mathematics teachers.

(Ministry of Education, Victoria, 1990a, Introduction, p. 2)

Specific features of the program design, including its delivery, content, and structure, were critical to the realisation of these aims. Details of these design features follow.

The Program Design

Delivery of the program

EMIC courses were conducted by trained tutors who were experienced mathematics teachers or consultants. The tutors participated in an intensive fifteen day live-in training program certified by the Victorian Ministry of Education. The tutor training program modelled the various components of EMIC and provided opportunities for the tutors' own professional development related to mathematics education and teacher development. This was done through participation in workshops and seminars presented by recognised experts in the fields of mathematics education and teacher professional development, and extensive professional reading.
EMIC tutors were responsible for the organisation and delivery of the program, as well as between session support for participants. Details of this between session support will be discussed later in this section. Tutors were provided with a comprehensive tutor manual to work from, which included presentation notes, overhead transparencies and handouts for each workshop session (Ministry of Education, Victoria, 1990b). Whilst the format and content of workshop sessions was prescribed in the tutor manual, tutors were encouraged during training to be flexible in their program delivery to meet the needs and interests of course participants. In addition to the tutor manual, tutors were given a range of teacher reference books related to mathematics teaching, and current research papers to refer to during the courses.

Program tutors were provided with three kinds of formalised support to assist them in conducting EMIC courses. These were: release from other duties, financial resources, and opportunities for professional collaboration.

Tutors were allocated 10 teacher release days for each course conducted. These days enabled them to prepare the course workshop sessions, perform administrative functions associated with the conduct of the course, and provide support to teachers throughout the duration of the course.

A resource allocation of $300 was also made for each course. Tutors were able to use these funds to assist them in conducting the courses. Ways in which tutors chose to spend these funds included:

- the purchase of books referred to in the program so that course participants could borrow them;
- the purchase of mathematical materials or equipment; and
- the purchase of stationery.

A further type of formalised support provided to tutors was professional collaboration. Staff responsible for numeracy programs in each of the Ministry of Education's regional areas organised regular forums for EMIC tutors to meet and share information related to the conduct of courses. Through this process several tutor networks formed across the state. In addition to regional level support, an appointed State Coordinator of the EMIC program organised conferences for EMIC tutors on a statewide level. These conferences provided additional professional development for tutors, opportunities to address concerns related to the program, and the initial collection of information for reviewing the program.
EMIC tutors were responsible for the professional delivery of the program. While the structure and content of the EMIC program can be found in the program documentation, the program as experienced by participating teachers was critically dependent on the role played by the tutor. For the teachers in this study, their experience of EMIC was to a large extent their experience of one particular tutor's implementation of the program. The central significance of the tutor role must be taken into account in any attempt to generalise from the results of this study.

Content of the program

EMIC comprised a series of ten workshop sessions which encouraged teachers to explore different aspects of mathematics teaching. The title and principal focus of each workshop is outlined in Table 3.1. Specific details regarding each of the EMIC sessions are outlined in the EMIC Participant’s Logbook (Ministry of Education, Victoria, 1990a).

As stated earlier, the program focused on pedagogy. There were specific emphases in the program. In particular, a constructivist view of learning both guided the implementation of EMIC and represented a significant aspect of its content. In each EMIC workshop, use was made of ideas drawn from the work of a number of mathematics education researchers. In addition, Ministry of Education policy and program documents were referred to, as well as a variety of books related to mathematics education. A complete listing of theoretical and practical references for each of the workshops is documented in the EMIC Participant’s Logbook (Ministry of Education, Victoria, 1990a).

Structure of the program

The EMIC workshops were planned to run for two hours each and were typically conducted after school hours either weekly or fortnightly. Participation of groups of three or four teachers from each of a number of schools was recommended. It was suggested that the most appropriate number of participants for each course would be 12, however actual numbers varied.

The workshops were designed to involve teachers in practical activities which utilised their own knowledge and experiences, as well as inform them of recent developments in mathematics education. Whilst the workshops had particular content foci, tutors who conducted the courses were able to adapt the suggested procedures and activities
Table 3.1
Overview of the Foci of the EMIC Workshops

<table>
<thead>
<tr>
<th>WORKSHOP NO.</th>
<th>TITLE</th>
<th>FOCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Real Mathematics / School Mathematics</td>
<td>• to consider a definition of mathematics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• to compare school mathematics with mathematics used in the wider community</td>
</tr>
<tr>
<td>2</td>
<td>Observing and listening to children</td>
<td>• to consider the importance of observing and listening to children as they do mathematics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• to explore effective observation and listening strategies</td>
</tr>
<tr>
<td>3</td>
<td>Children learning mathematics</td>
<td>• to examine students' mathematics learning strategies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• to explore teaching strategies that build on students' knowledge</td>
</tr>
<tr>
<td>4</td>
<td>Relating the child's world to mathematical concepts</td>
<td>• to explore the importance of linking student knowledge and experience in mathematics learning</td>
</tr>
<tr>
<td>5</td>
<td>Children and teachers talking about mathematics in the classroom</td>
<td>• to consider the importance of discussion and questioning in mathematics learning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• to explore effective discussion and questioning strategies</td>
</tr>
<tr>
<td>6</td>
<td>Inviting children to learn mathematics together</td>
<td>• to explore the use of cooperative learning in mathematics</td>
</tr>
<tr>
<td>7</td>
<td>Children representing and recording their mathematics</td>
<td>• to consider the benefits of students recording, representing and communicating mathematics in varied ways</td>
</tr>
<tr>
<td>8</td>
<td>Collecting quality assessment information in mathematics</td>
<td>• to consider the purpose of assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• to explore a range of alternative assessment strategies</td>
</tr>
<tr>
<td>9</td>
<td>Teachers, parents, children and mathematics</td>
<td>• to explore the role of parents in children's mathematics learning</td>
</tr>
<tr>
<td>10</td>
<td>Planning a classroom mathematics program</td>
<td>• to review themes presented in the program</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• to explore issues related to classroom program and whole school planning</td>
</tr>
</tbody>
</table>

to meet participant needs. During each session, teachers were typically involved in:
• sharing ideas and resources;
• reflecting on their current teaching practice;
• exploring and discussing activities they could experiment with in their classrooms; and
• discussing issues raised in the professional literature provided.

Specific workshop components were developed for these purposes. Table 3.2 outlines each of these components and the typical time allocated to each one. A key element of this session format was the choice afforded to teachers; each participant could make
use of the activities and readings presented in the program in ways that would suit their own professional needs and interests.

In addition to the structured workshops, a further aspect of the program was the provision of support and feedback from the program tutor. Tutors were expected to visit participants at their schools between sessions to provide ongoing support. The type and frequency of support were negotiated between participants and tutors to ensure that participant needs could be met. Types of support often provided by tutors included: team teaching sessions; demonstration sessions; discussions about resources; and, arranging teacher release to visit and observe other classrooms.

From the description outlined above, it can be seen that the EMIC program:

- addressed recent developments related to mathematics education (see Content of the program);
- informed and supported teacher development (see Aims of the program, Content of the program, Structure of the program);
- focused on teachers as learners (see Structure of the program);
- catered for varied teacher needs, interests and backgrounds (see Structure of the program);
• addressed conditions needed for teachers to learn and implement new teaching strategies repertoire (see Content of the program, Structure of the program); and
• engaged school level support, and encouraged collegiality (see Structure of the program).

The following section provides an outline of the procedure of the study.

3.3 Outline of the study

3.3.1 Structure of the study

Having chosen case study as the research approach and EMIC as the professional development program for investigation, a procedure for examining teacher change in this context was needed. For this purpose I developed a two phase structure for the study. In Phase One the aims of the EMIC program were analysed to determine foci for examining the professional growth of EMIC teacher participants. In Phase Two the investigation of teacher professional growth was conducted. An overview of these phases and the timeframe of the study are presented below.

3.3.2 Overview of the study phases

The purpose of the first phase of the study was to determine foci for examining the professional growth of EMIC teacher participants. I considered a comprehensive understanding of the intent of the program crucial for determining these foci, as without such an understanding it would be difficult to recognise and examine the professional growth of teachers involved in the program. The process used to determine these foci consisted firstly of an examination of the EMIC program documents, and secondly, the gathering of information directly from the developers of the program. To obtain information from the program developers, I developed and distributed a questionnaire. I then used responses to the questionnaire along with the program’s documented aims to develop a framework for focusing the investigation of teacher change in this study. Details of this phase of the study, including the development, distribution, analysis and findings of the questionnaire are presented in Chapter 4.
Phase Two of the study involved the investigation of teacher change and the subsequent investigation of teacher professional growth. Using the framework developed in Phase One as a guide, I collected and analysed data from six teacher participants involved in one EMIC course. During this phase a significant finding of the study, the distinction between change and growth, led to a refined focus for the study. The investigation of teacher professional growth became the central research purpose. A detailed description of this phase of the study, including the selection of the EMIC course and teachers, and details of the data collection and analysis techniques, is provided in Chapter 5. The findings of the investigation are then reported in Chapters 6, 7, 8 and 9.

3.3.3 The study timeframe

Table 3.3 provides an overview of the study timeframe. It outlines the different periods in each phase of the study and the purpose of those periods.

There were four main time periods in the study. There was one time period specific to Phase One and three that were central to the process of data collection and analysis in Phase Two of the study. As can be seen in Table 3.3, this was a longitudinal study of teacher professional growth. The study investigated the professional growth of six teachers over an 18 month period.

Reference to the different time periods displayed in Table 3.3 will be made in describing the process of data collection and analysis, and in reporting the findings of the study.
<table>
<thead>
<tr>
<th>PHASE</th>
<th>TIME PERIOD</th>
<th>DATES</th>
<th>PURPOSE</th>
</tr>
</thead>
</table>
| ONE             | Prior to the EMIC program        | July – October 1990 | • To determine areas of expected teacher change for EMIC program participants  
                           |                    |                                                                                  | • To develop a framework for investigating teacher change in Phase Two of the study |
| TWO             | During the EMIC program          | April – August 1991 | • To gather baseline data against which change and growth could be identified  
                           |                    |                                                                                  | • To observe the participants’ initial response to the EMIC program, including the exploration of program ideas in their mathematics teaching practice |
|                 | Soon after the EMIC program      | September 1991 – April 1992 | • To gather information related to any demonstrated or perceived change in the participants’ mathematics teaching practice  
                           |                    |                                                                                  | • To identify factors that may influence the professional growth of the teachers |
|                 | 10–12 months after the EMIC program | May – September 1992 | • To determine whether any long lasting change was demonstrated in teachers’ practice, or reported by them  
                           |                    |                                                                                  | • To identify factors that may have influenced the professional growth of the teachers over time |

### 3.3.4 Issues and constraints

The most significant constraint in this study was time. In particular, the longitudinal nature of the study, and the conduct of this research part-time over a period of eight years (initially for the degree of Master of Education and later converted to the degree of Doctor of Philosophy) created several difficulties. Paradoxically, however, I consider the long time taken to complete the study to have contributed positively to the research outcomes.

One difficulty associated with the longitudinal nature of the study related to the accessibility of the study participants. As would be expected in research studies where teachers are the study participants (at least within the Victorian education system), the movement of teachers between schools to secure positions or to gain promotion within the system was a factor to contend with. This study was of no exception. One of the six teacher participants, Brian, moved to a school 350 kilometres from the original study site to secure an ongoing teaching position. This
made it difficult to make classroom observations and conduct interviews during eight months of the study. As a result, fewer classroom observations were possible for this teacher. In the case of one other teacher, Cath, a temporary promotion at her current school location meant that she was relieved of classroom duties for three months during the data collection period. Consequently fewer observations were made in her classroom.

A further associated problem related to accessing information from the program tutor. During the latter period of the study, she resigned from the Victorian Ministry of Education and relocated overseas. This meant that I was unable to interview her as I had proposed. The solution developed worked effectively, and in my opinion even enhanced the collection of data in this case. Rather than resort to a questionnaire, which was an option considered but later rejected as it would not provide the detailed kinds of responses I was seeking, I decided to mail to the tutor an adapted interview schedule and two audio tapes to record her responses. She was asked to record answers to the interview questions on the tape which she would return to me. When the tape was returned the interview responses were fully transcribed and analysed. Benefits of this approach were several. First, it was economical and time efficient. Second, the tutor suggested that it was useful to have the opportunity to reflect on the interview questions over time, rather than being pressed for answers in the (typically) more formal setting of an interview. The tutor stated that she took several days to actually complete her responses to all of the interview questions. She noted the ease with which she could pause or stop recording if she wanted to contemplate her answers further. She also pointed out that she could add to the tape previously omitted details that she considered important “as she thought of them”. In summary, this alternative approach was both cost and time effective, and provided data arguably richer than that usually acquired through interview.

I found the spread of time over which this study was conducted of particular concern with regard to maintaining a much needed intimacy with the research data. Periods between opportunities for working with my data were often long for a range of professional and personal reasons. This often caused me to lose touch with my developing knowledge of the data, necessitating the constant revisiting of past observations and ideas.

Two strategies proved useful for minimising disruptions at these times. First, throughout the study I maintained research memos, usually in the form of notes and diagrams. These memos proved invaluable for linking my ideas both as I was working
with the data and after time away from it. Throughout the study I dated all memos to enable me to track the chronological development of my thoughts and ideas. Second, as far as possible I ensured that my data were at all times organised in a form that would enable me to easily access different data as it was needed. This was done through developing a manually coded storage system for my “hard data” (including interview transcripts, observation records, questionnaire responses, memos and data displays), and an efficient filing system for the data stored on computer (including interview transcripts, categorisation schemes, and chapter drafts).

A further difficulty experienced through the extended time taken to complete this research related to writing this thesis retrospectively. During the “writing-up” of the research, it was at times difficult to recall some of my motives for earlier decisions made, although memos proved useful in this regard. It should therefore be noted that the descriptions of the study design and research outcomes presented in this thesis, are shaped markedly by my current perceptions of those rather than any earlier ideas.

While the prolonged period over which the conduct of the study was on the one hand difficult and frustrating, it also provided undoubted opportunities for me to learn more about my topic and education research generally. My various professional roles through this time challenged and encouraged my own learning. Over this period I developed and refined my knowledge and skills related to the research topic, and the craft of research. Further, across the time of the study developments in the field reported in the research literature provided valuable insights, particularly with regard to informing the process of analysis in this study. For example, the theoretical model that was used in the analysis of the data was first published part way through this study in 1993.

The following chapter describes the first phase of the study.
Chapter 4
Phase One: Identifying areas for investigation

Having decided on the research questions, research approach and professional development program to be used as the vehicle for the investigation in this study, my next question in the design process was how to focus the investigation of teacher change in this context. I considered the answer to this question to be the key to the effective design of the study, as it would inform the data collection methods employed and the data sources needed. Therefore I decided to treat the process of answering this question as a distinct phase in the study; one that would exist in its own right with purposes, methods, and findings.

I considered a comprehensive understanding of the intent of the Exploring Mathematics In Classrooms (EMIC) program necessary background information for investigating change in this context—without such an understanding it would be difficult to recognise and examine teacher change. Therefore, in this first phase I analysed the broad aims and purposes of Exploring Mathematics In Classrooms (EMIC), as outlined in the program documents, together with the specific views of those who developed the program, in order to understand the intent of the program and to determine areas of expected teacher change for EMIC participants. I used these areas of expected teacher change to guide the development of a framework for the Phase Two investigation.

This chapter describes this first phase of the study. It begins with a discussion of the background to the development of the EMIC program. This discussion provides a context for the use of a questionnaire directed at the acknowledged developers of the program to determine their views of the program aims and objectives. Details of the purposes, design, distribution, analysis, and findings of the questionnaire are then provided. The final section of this chapter describes the way in which the questionnaire and program document analyses guided the development of the tentative framework for investigating teacher change in the second phase of the study.
4.1 Setting the context: Background to the development of EMIC

Exploring Mathematics In Classrooms (EMIC) was initiated in Victoria in 1984 as part of the Commonwealth funded Basic Learning In Primary Schools (BLIPS) program. The intent of the BLIPS program was to raise standards in literacy and numeracy in primary schools. Funding was allocated to state education systems for this purpose. In Victoria, the numeracy strategy associated with this funding led to the development of the EMIC program and another professional development activity, Mathematics Key Groups (Robinson, 1987).

The idea for a ten-week inservice program related to mathematics teaching was conceived from the literacy program, Early Literacy Inservice Course (ELIC). That program, first developed in New Zealand and later implemented in South Australia, was highly regarded in those education communities, not only with respect to its content, but also in terms of the professional development model itself. Representatives of both the Victorian BLIPS team (those responsible for the management and delivery of the projects associated with the BLIPS funding) and the Commonwealth BLIPS committee favoured the development of a mathematics inservice program based on that professional development model (see Section 3.2.3 for a description of the model).

Early in 1985, the Victorian BLIPS team organised meetings of consultants, teacher educators, and teachers to discuss and develop ideas for the program. Some initial program proposals were prepared during this process, however the content and structure of the program were not formalised at this time. Mid-way through that year, two teacher-consultants were seconded for three days each week to draw up specifications and an overview for the program. This work continued into 1986. Two full-time appointments were made for twelve months, during which the writing and trialing of the first draft of EMIC occurred. Throughout this process the writers consulted with members of the BLIPS team and also with working parties that were formed to act as reference groups for the program development.

In 1987, the writing and trialing of a second draft took place, and the first two tutor training programs were conducted. Trained tutors conducted the program throughout 1987 and 1988. In 1988, a full-time project manager (titled EMIC State Coordinator) was appointed to coordinate the tutor training and the implementation of EMIC courses across the state.
Toward the end of 1988, an informal evaluation of the program was conducted during a statewide conference for tutors. Later, a third draft of the program was proposed. A working party was formed to oversee the program revision in consultation with the EMIC State Coordinator and those contributing to the program rewrite. For the writing of the third draft, rather than engage one or two writers full-time to make changes to the entire program, the task was “outsourced” and divided among a number of writers, according to the focus of the particular workshop content.

The writing of the third and final draft was completed in 1989. Programs continued to be conducted throughout that year, and for several years following. In 1991 with no further central sources of funding for the program, the position of EMIC State Coordinator was discontinued. Programs conducted after this time were managed at regional and local levels.

As can be seen from this account, many different people contributed to the development of EMIC since its inception. The types of involvement of different individuals and groups varied considerably. No attempt has been made to either quantify or qualify any aspect of that involvement. For ease of reference throughout this chapter however, the term “developers” will be used to refer to any of the people formally acknowledged in the program documentation (Ministry of Education, Victoria, 1990a) as contributors to the program. Similarly reference will be made to a “developers questionnaire” which was directed specifically at these acknowledged contributors.

4.2 The questionnaire

4.2.1 Purposes

In order to guide the development of a tentative framework for the investigation in Phase Two of the study, I decided to examine the aims and objectives of the EMIC program, as these could be expected to reflect areas of anticipated teacher change. The EMIC program documents provided the initial source for this examination. However another source was needed to provide the level of detail I required. I considered that this detail could best be provided by a survey of the program developers for the following reasons.

First, while objectives of the EMIC program were implied in the stated aims, and in the purposes described for each of the ten EMIC workshops (see Section 3.2.3), the
program documents contained no explicit statement of expected outcomes. I felt that this represented a “gap” in the information needed for focusing the investigation of teacher change in this study. Specifically, I considered that I needed a comprehensive understanding of the intent of the program to be able to appropriately investigate change in this context.

I considered that a survey of the program developers could provide further details related to the program aims and objectives and, in addition, some information related to the expected outcomes. I anticipated that the EMIC developers, many of whom were program tutors or were involved in training tutors, could provide details related not only to the intended outcomes of the program, but also to the outcomes observed through their work in these roles. I thought that this information could inform the development of a framework for investigating teacher change in the second phase of the study. In particular, I planned to use the developers’ views of the kinds of observable behaviours that EMIC participants might demonstrate as a guide for developing this framework.

Second, the historical context of the development of EMIC (described in Section 4.1) meant that the documented aims of the program were shaped by a range of political, professional, and personal factors associated with the writing and subsequent official approval of the program. It could not be assumed therefore that the aims were representative of the views of all of the many contributors to the program development. A survey of the developers could provide insight into their different perspectives of the program, and confirm or refute the stated program aims.

Third, as an EMIC tutor, my interpretations of the program aims and expected outcomes were shaped by my experiences of the program and the associated biases created through those experiences. While I recognise the valuable contribution this experience brings to this study, my intention was to develop a more representative view of the program aims and objectives; a survey of the program developers would enable me to construct such a view.

The instrument I used for surveying the EMIC developers was a questionnaire. The potential “costs” associated with interview methods, particularly in terms of geographical, financial and time constraints, made that option unviable, as there were 24 developers located across Victoria and interstate. I considered a questionnaire to be a practical alternative that would enable reliable and valid information to be collected.
4.2.2 Design and distribution

The questionnaire, which is displayed in a reformatted form as Table 4.1, was designed and trialed with a group of EMIC tutors, and then distributed to the program developers in the period six months prior to the commencement of the EMIC course investigated in Phase Two of the study.

Table 4.1
The EMIC Program Developers Questionnaire (reformatted)

<table>
<thead>
<tr>
<th>COMPONENTS</th>
<th>QUESTION NUMBER</th>
<th>QUESTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE OF INVOLVEMENT IN THE PROGRAM</td>
<td>1</td>
<td>Give a brief description of your contribution to EMIC. (Include details of your involvement in discussions, working parties, unit writing etc., and approximate dates of your involvement in these areas.)</td>
</tr>
<tr>
<td>VIEW OF THE PROGRAM OBJECTIVES</td>
<td>2</td>
<td>At the time of your involvement in contributing to EMIC, what did you consider were the overall objectives of the program?</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>How did your own objectives (related to your specific areas of involvement) compare with the overall objectives?</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>What do you consider to be the major thrust(s) of the program?</td>
</tr>
<tr>
<td>VIEW OF THE PROGRAM OUTCOMES</td>
<td>5</td>
<td>What do you consider the outcomes for EMIC participants have been?</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>On what information have you based your response to question 5?</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>As mentioned in the accompanying letter I am intending to investigate the effectiveness of the EMIC program. What observable changes in teacher behaviour do you consider I should be looking for?</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>What factors are you aware of that have had a positive impact on the effectiveness of EMIC?</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>What factors have had a negative impact on the program effectiveness?</td>
</tr>
<tr>
<td>VIEW OF POTENTIAL CHANGES TO THE PROGRAM</td>
<td>10</td>
<td>If you were writing the EMIC program now, what changes (if any) would you make?</td>
</tr>
</tbody>
</table>

The questionnaire comprised ten short answer questions. The questions whilst addressing particular foci, were open ended in design in order to allow respondents the opportunity to provide all the information they considered relevant. Respondents
were instructed to complete each question in the space provided on the original questionnaire, and were invited to elaborate their responses on additional pages if they wished to do so.

Table 4.1 shows the way I structured the questionnaire to include the following components:

- type of involvement in the program;
- views of the program objectives;
- views of the program outcomes; and
- views of potential changes to the program.

As indicated in Table 4.1, the majority of the questionnaire items related to the developers' views of the program objectives and their views of the program outcomes. The reason for this emphasis was the anticipated use of the information provided by respondents to guide the development of a framework for focusing the investigation of teacher change in the second phase of the study.

My main interest was in the responses to Question 7. That question asked the developers to describe observable changes in teacher behaviour that participants in the EMIC program might demonstrate. I considered that their views of observable changes in participants' behaviour would be particularly useful for guiding my construction of a framework for investigating teacher change. I further considered that, in order to understand these views, it was imperative that I seek some background information related to the developers' ideas. For example, in order to understand the context of their ideas related to the expected outcomes of the program, I needed to know what they thought of the aims and purposes of the program. The other questions provided opportunity to collect this information.

Question 1, which related to the developers' type of involvement in the program, was intended to elaborate details of their contributions. Through my own involvement in the program over several years, and my research of the program history, I had some knowledge of the involvement of each of the acknowledged program developers. However I considered their own reporting of their involvement as a potentially important source of data.

Questions 2–4 were designed to obtain essential background information related to the developers' views of the program objectives. Questions 2 and 3 asked the developers to describe the overall ("official") objectives of EMIC, and how their own objectives
for the program compared with the official objectives. In Question 4, I sought to identify the developers' views of which objectives they considered to be priorities.

Questions 5 and 6 sought the developers' views of the program outcomes, and the background to those views. I anticipated that responses to these questions would, for some developers, include their views of both the intended outcomes of the program and those outcomes they had observed in their various roles associated with the program.

Questions 8 and 9 related to factors that have had a positive or negative impact on the effectiveness of the program. I thought that the developers' views of these could guide my investigation of characteristics of the professional development program that appear to influence teacher development.

Question 10, which related to the developers' views of potential changes to the program, was intended to provide an opportunity for the developers to reflect and report on elements of the program they considered in need of change. I thought that responses to this question might include some direct and indirect ideas associated with the program outcomes and objectives in which I was interested.

Questionnaires were sent out by mail to each of the 24 program developers acknowledged in the EMIC Participant’s Logbook (Ministry of Education, Victoria, 1990a). Fourteen responses were received and analysed.

4.3 Analysis

The process of analysing the questionnaire data began with the sorting of all responses by question. For this purpose I transcribed the responses for each question creating separate computer files for each one. I considered that this would enable me to retrieve, sort, and manipulate the data efficiently during the analysis process.

I then read and re-read the data related to each question in a search for emergent patterns. I recorded memos related to my search for patterns, and gradually began a process of categorising the responses.

I used key terms drawn directly from the responses to label emergent categories. For example, in response to Question 7, one developer wrote that "willingness to reflect on one's own practice" was an observable behaviour that might indicate the effectiveness of EMIC. The key term drawn from this statement that became a category title was
"REFLECTION". For ease of use, codes were developed to abbreviate category titles. The code "REF", for example, was applied to responses that related to the category "REFLECTION". During this process categories were collapsed, extended, redefined or abandoned. I continually re-read the data to ensure that as I developed new categories they were uniformly applied. Once all of the responses were coded, I grouped them together in their categories, creating separate computer files for each category.

For some questions, only a few categories emerged and I decided to regard these as broad themes that I could use to describe the developers' responses. For these questions, I created tables to display the responses included within each broad theme, and simply described the data associated with each one (see for example, Table 4.3 and the related discussion on page 90).

For other questions, where there were many emergent categories which were more specific in nature, I continued the classification process by looking for patterns amongst the different categories, and grouping categories together to form themes. For example, in analysing responses to Question 7 which asked the developers to describe observable changes in teacher behaviour that participants might demonstrate, I formed a theme associated with teachers' "Professional Attributes" by grouping together the categories: Confidence, Attitude, Collegiality, Experimentation and Reflection (see Table 4.7, p. 98, for a complete listing of this theme).

At times it was necessary to classify some responses as "Other". For example, in response to Question 8 one developer wrote that a factor that has had a positive impact on the effectiveness of EMIC was the "nice afternoon tea[s]". The five themes relating to factors which had a positive impact which emerged from the data analysis were: Program Structure and Content; Development of the Program; Program Tutors; Professional Development Culture; and School Level Support (see Table 4.10, p. 102). This response fitted none of these themes and did not warrant a new theme of its own.

Tables were used to display the final categories and themes decided on for each of the questionnaire's structural components: type of involvement in the program; views of the program objectives; views of the program outcomes; and views of potential changes to the program. Findings related to each component of the questionnaire are reported below.
4.4 Findings and discussion

4.4.1 The type of involvement of the developers

The type of involvement in the program of the different developers varied considerably. Among the 14 respondents there were representatives of six groups who played key roles in the development and implementation of EMIC since its inception:

- the original writing team who worked on the project from 1986;
- working groups and editorial teams who worked closely with the original writing team;
- the writing team involved in the rewrite of the program in late 1988 and early 1989;
- working groups and editorial teams associated with the 1988–1989 rewrite of the program;
- organisers and providers of the tutor training programs; and
- tutors who conducted EMIC courses.

Table 4.2 provides an overview of the type of involvement in the program of the 14 questionnaire respondents.

Two developers (Developers 6 and 8) were involved in the development of the original program only, five developers (Developers 1, 2, 4, 11, and 14) were involved in both the original program and the 1988–1989 program rewrite, and seven developers (Developers 3, 5, 7, 9, 10, 12, 13) were associated specifically with the program rewrite. All of the developers except the two who were exclusively associated with the original program (Developers 6 and 8) reported multiple roles in the program development. Seven of the 14 developers (Developers 2, 4, 5, 10, 12, 13, and 14) had experience with the practical implementation of the program in their role as program tutors. Eleven developers (Developers 1, 2, 3, 4, 5, 7, 9, 11, 12, 13, 14) were involved in the training of tutors.
Table 4.2

Overview of the Type of Involvement of the EMIC Program Developers

<table>
<thead>
<tr>
<th>DEVELOPER (Numbered by receipt of questionnaire return)</th>
<th>ORIGINAL WRITING TEAM</th>
<th>ORIGINAL WORKING GROUP/EDITORIAL TEAM</th>
<th>REWRITE WRITING TEAM</th>
<th>REWRITE WORKING GROUP/EDITORIAL TEAM</th>
<th>TUTOR TRAINING PROVIDER/ORGANISER</th>
<th>COURSE TUTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>4</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
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<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
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<tr>
<td>9</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

Occasionally, the "historical" accounts of their involvement provided by the developers revealed information related to personal, professional and political issues associated with the program development. For example Developer 6, who was a member of the original working group, suggested that there was a "hidden agenda" regarding the adaptation of the Early Literacy Inservice Course (ELIC) model in the early discussions of the program. He suggested that while another professional development model was favoured by most people involved in the discussions, there was a political agenda to be met in the development of a mathematics program that looked like ELIC. A statement written by Developer 8 similarly noted, "I recommended [a] network scheme for maths (for a lot of reasons) but [the] Commonwealth and State wanted the structure of an ELIC" (Developer 8, p.1).

Developer 6 further explained how he was involved at a very early stage in preparing a first draft of the program. He described the foci that he had selected, and stated that "a major difference [from ELIC] was that whereas ELIC contained no subject matter
**per se,** EMIC ... did require teachers to do some mathematics" (Developer 6, p.1). He wrote the following account of the “unfavourable” feedback he was given on the draft “from a group who had been through ELIC”:

The review comment I remember (it must have cut me to the quick to be remembered after all these years) was that it (EMIC) "was a typical teacher’s college course". My only feeling is that that person must have been through an innovative course! However, I awaited further instructions ... and they never came! My involvement, it appeared, was over! (Developer 6, p.1)

It appeared that his view of the purpose of the program differed significantly from the views of the group who provided the review, and from the decision-makers who commissioned the subsequent development of the program.

A further example of the kinds of professional and personal information revealed in the developers’ responses came from Developer 4, who, as indicated in Table 4.1, was involved at almost every stage of the development of the program from its inception. This developer was one of the two teacher-consultants engaged full-time to write the original version of the program. As part of the detailed account of his involvement in the program over the years, he wrote that as well as “running EMIC programs” in 1988–1990, he “developed [his] own version of [the] third draft as [he was] dissatisfied with [the] official version” (Developer 4, p.1). One explanation for his apparent negative view of the changes made to the program in the third draft, is that those changes were significantly different from the original version; the version that he had developed. A range of professional and personal ties to the original version of the program may have influenced his view of the third draft.

The developers surveyed were found to have had a range of roles in the program development. The data related to the backgrounds of the developers provided insight into their different perspectives of the EMIC program. This information was particularly useful when interpreting the developers’ responses to other items included in the questionnaire. It appeared that the developers’ own experiences of EMIC, in combination with their personal and professional experiences, led to disparate views of the program. While it would have been interesting to pursue in more detail the developers’ different views, and the possible effects of those views on the program, it was beyond the scope of this study to explore these areas further.
4.4.2 The developers' views of the program objectives

Data from Questions 2 and 4

Table 4.3 displays the program objectives identified by the developers in their responses to Question 2 related to the “overall objectives” of the program, and to Question 4 related to the identification of priorities ("major thrusts") amongst the program objectives. The objectives are organised in the table according to three broad themes that emerged. These were: Improvement of Mathematics Teaching and Learning; New Ideas and Information; and Extension of Teachers' Methods and Strategies for Teaching Mathematics. Responses that did not fit any of these themes are displayed as Other. Numbers in parentheses indicate the number of respondents who identified each objective.

While the 14 developers expressed their views of the program objectives in different ways and with different emphases, there are strong links between their ideas and the official aims of the program. First, a fundamental aim of the EMIC program was to improve the teaching and learning of mathematics. This rudimentary purpose was basic to the program since its inception as part of the Commonwealth funded Basic Learning In Primary Schools (BLIPS) project (see Section 4.1). Nine responses related to this "global" purpose. These were categorised together as relating to the Improvement of Mathematics Teaching and Learning. Second, direct links with the stated aims of EMIC (Ministry of Education, Victoria, 1990a), can be seen in the developers’ responses, most notably in the themes: New Ideas and Information, and Extending Teachers’ Methods and Strategies for Teaching Mathematics. Many of the suggested objectives included in these themes relate closely to three of the program’s stated aims, which were to provide opportunities for teachers to: consider current developments in mathematics education; increase their awareness of how children learn mathematics; and try out and consider adopting new teaching and learning strategies (Ministry of Education, Victoria, 1990a). To reflect the lesser emphases on responses associated with the other stated aims of the program (specifically those related to teachers reflecting on their current practice, investigating the role of parents in children’s mathematics learning, sharing and working cooperatively together, and gaining confidence in teaching mathematics), these were included within the themes I developed rather than forming themes in their own right.
<table>
<thead>
<tr>
<th>THEMES</th>
<th>OBJECTIVES</th>
<th>PRIORITIES (&quot;MAJOR THRUSTS&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Number of respondents in parentheses)</td>
<td>(Number of respondents in parentheses)</td>
</tr>
<tr>
<td>IMPROVEMENT OF MATHEMATICS TEACHING AND LEARNING</td>
<td>• improve mathematics teaching and learning (2)</td>
<td>• improve mathematics teaching and learning (1)</td>
</tr>
<tr>
<td></td>
<td>• change way mathematics being taught (1)</td>
<td>• improve students' mathematical understandings (1)</td>
</tr>
<tr>
<td></td>
<td>• challenge traditional approaches to learning and teaching mathematics (1)</td>
<td>• help teachers develop maths programs in which children meaningfully construct mathematical relationships in real-world contexts (1)</td>
</tr>
<tr>
<td></td>
<td>• improve learning by showing teachers new/better techniques (1)</td>
<td>• modelling good teaching (1)</td>
</tr>
<tr>
<td></td>
<td>• improve teachers' program planning to ensure long-term implementation of desired change (1)</td>
<td>• revitalise the teaching of mathematics (1)</td>
</tr>
<tr>
<td>NEW IDEAS AND INFORMATION</td>
<td>• introduce current educational/mathematical issues (1)</td>
<td>• introduce and explore models of learning (5)</td>
</tr>
<tr>
<td></td>
<td>• increase teachers' awareness of students and how they learn (1)</td>
<td>• make teachers aware of alternative assessment strategies (3)</td>
</tr>
<tr>
<td></td>
<td>• introduce teachers to a constructivist view of learning (1)</td>
<td>• explore the significance of language in mathematics learning (2)</td>
</tr>
<tr>
<td></td>
<td>• increase teacher knowledge (1)</td>
<td>• give practical face to constructivist view of learning (1)</td>
</tr>
<tr>
<td>EXTENSION OF TEACHERS' METHODS AND STRATEGIES FOR TEACHING MATHEMATICS</td>
<td>• broaden range of classroom strategies available to teachers (2)</td>
<td>• introduce teachers to a constructivist view of learning (1)</td>
</tr>
<tr>
<td></td>
<td>• bring teachers together to share collective wisdom and build on it (2)</td>
<td>• increase teachers' awareness of current trends in mathematics education (1)</td>
</tr>
<tr>
<td></td>
<td>• provide opportunities for teachers to try new approaches, reflect on them with the support of colleagues/critical friends (2)</td>
<td>• growing consensus re how mathematics teaching is changing and must change (1)</td>
</tr>
<tr>
<td></td>
<td>• give teachers confidence to try new approaches (1)</td>
<td></td>
</tr>
<tr>
<td>OTHER</td>
<td>• increase teachers' confidence (1)</td>
<td>• increase teachers' range of teaching strategies (2)</td>
</tr>
<tr>
<td></td>
<td>• teacher development (1)</td>
<td>• assist teachers to reflect on their practice, try out and adapt new strategies (1)</td>
</tr>
<tr>
<td></td>
<td>• develop maths inservice program (1)</td>
<td>• encouraging and supporting teachers trying new approaches (1)</td>
</tr>
<tr>
<td></td>
<td>• keep up with developments in language [English] (1)</td>
<td>• provide opportunities for teachers to try new approaches, reflect on them with the support of colleagues/critical friends (2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• bring teachers together to share collective wisdom and build on it (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• sharing of good practices between teachers and schools (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• mathematics should be seen and taught in integrated way (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• practical contexts (1)</td>
</tr>
<tr>
<td></td>
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<td>• hands-on experiences (1)</td>
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<td></td>
<td></td>
<td>• cooperative learning (1)</td>
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<tr>
<td></td>
<td></td>
<td>• involving parents (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• reaffirm teachers are doing good things (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• what we can learn from students (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• professional development (1)</td>
</tr>
</tbody>
</table>
Few of the program objectives expressed by the developers were significantly different from the ideas contained in the EMIC program documentation. An exception to this was a response given by Developer 6. He wrote that an objective of the program related to being seen to be “keeping up with developments in [English] language teaching” (Developer 6, p.1). It appeared that in giving this response he was attempting to portray his perception of the political motivation for the development of the program.

Data from Question 3

Responses to the question “How did your own objectives (related to your specific areas of involvement) compare with the overall objectives?” varied considerably. Table 4.4 displays my categorisation of the program developers’ reported congruence between their own objectives for the program and the official program objectives.

One developer actually reported his own objectives as having “high-level congruence” with the overall program objectives (Developer 4). I grouped the response of this developer with four others who implied high-level congruence (Developers 7, 9, 11, and 14). I categorised two developers as having medium-level congruence (Developers 1 and 12). They reported their objectives were “similar” to the overall program objectives. Others suggested that their ideas were “at variance” with those objectives recognised as official (Developers 3, 6, and 8). I categorised these developers as having low-level congruence. A further group (Developers 2, 5, 10, and 3) stated that they did not understand the question. This group are represented in Table 4.4 as having made no response. I concluded from the number of respondents in this group that this question needed to have been better designed. While I had made several attempts at wording the question appropriately, it was obvious from the responses of these four developers (at least) that the intent of this question was not clear. This should be considered when interpreting the following discussion of findings associated with this question.

Of the five developers I grouped together as having a high level of congruence between their own and the official program objectives, three were associated with both the original version of the program and the 1988–1989 rewrite (Developers 4, 11, and 14), and two were involved with the rewrite only (Developers 7 and 9). Developer 4 was one of the teacher-consultants responsible for writing the first official draft of the program. He reported, “seeing I was writing EMIC, there was a high degree of congruence” (Developer 4, p. 2). Developer 11 stated that a “close match” existed
Table 4.4

Levels of Congruence Reported by the Program Developers Between their Objectives for EMIC and the Official EMIC Program Objectives

<table>
<thead>
<tr>
<th>LEVELS OF CONGRUENCE</th>
<th>DEVELOPERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH-LEVEL</td>
<td>4 7 9 11 14</td>
</tr>
<tr>
<td>MEDIUM-LEVEL</td>
<td>1 12</td>
</tr>
<tr>
<td>LOW-LEVEL</td>
<td>3 6 8</td>
</tr>
<tr>
<td>NO RESPONSE</td>
<td>2 5 10 13</td>
</tr>
</tbody>
</table>

between his views and the official program objectives. He stated that the original program writers “were visionaries and they made a genuine effort to come to grips with [the] constructivist mathematics education literature” (Developer 11, p. 2).

Developer 9, who was exclusively associated with the program rewrite, noted a “close correspondence” but qualified this with “but then I may simply have had a pretty blinkered view of what others saw the program as achieving” (Developer 9, p. 2).

The two developers who reported some similarities between their own objectives and the official program objectives both qualified their responses. Developer 12, who was one of the first EMIC tutors trained and who was involved in working groups related to the program rewrite, wrote:

In most instances these [my own objectives and the program’s “official” objectives] are quite compatible—though I had (and still have) some concerns about the theorising of the course to the detriment of some of the more practical units. (Developer 12, p. 2)

Developer 1, who was involved in early discussions related to the development of the program, and later in the 1988–1989 program rewrite, reported:

[My objectives were] similar, though I believed that with the initial version of EMIC, a participant could complete the course without necessarily having gained mathematically at all. I felt that there needed to be a greater emphasis on empowering teachers (who lack confidence in their knowledge and understanding of maths) mathematically. (Developer 1, p. 2)
Similar concerns were raised by one of the developers who stated his views of the objectives were “at variance” with the official program objectives. Developer 6 was involved at a very early stage in preparing a first draft of the program; one that “required teachers to do some mathematics” (Developer 6, p. 1). That draft was rejected. Developer 6 reported:

As it turned out, my objectives and the EMIC committee/group’s objectives were obviously at variance. Compare my original somewhat sterile version with the current model. (Developer 6, p. 2)

Developer 8 noted similar concerns regarding the lack of mathematical content emphasised in the program. He stated:

In emphasising process over content, it had the paradoxical effect of keeping teachers weak on their content knowledge. Process was never linked to a deeper understanding of the maths involved. (Developer 8, p. 2)

Another developer who reported ideas at variance with the program’s objectives was Developer 3. She stated that she wanted a program that placed more emphasis on teachers learning about the mathematical development of children through direct observations of their cognitive behaviour, “not simply what they did and whether or not they enjoyed it [as in the existing program]” (Developer 3, p. 2). She reported EMIC was more about “getting a message across” and “conversion [of teachers] to accepted/current wisdom”.

The data related to the developers’ understandings of the program objectives proved useful for confirming the stated aims of EMIC, and my own interpretation of the objectives of the program. The ideas of the developers were, in general, consistent with the official stated aims of the program. While no “new” or different goals for the program were suggested by the developers, several reported that they did not like or agree with the official aims of the EMIC program.

4.4.3 The developers’ views of the program outcomes

Data from Questions 5 and 7

I categorised the developers’ responses related to their views of the program outcomes, including their views of observable changes in teacher behaviour, into 15 emergent categories. I then grouped related categories together to form three main themes. These were:
1. *Classroom Practice.* This theme included categories related to teacher actions specific to the organisation and implementation of the mathematics curriculum, for example use of particular teaching strategies or use of a variety of assessment strategies.

2. *Professional Attributes.* This theme included categories related to general professional attitudes and behaviours, for example experimentation or reflection.

3. *Knowledge and Beliefs.* This theme included categories related to teacher knowledge of, and beliefs about, mathematics and the teaching and learning of mathematics.

I grouped two categories that were not specifically related to these main themes together as Other. Rather than being outcomes relating specifically to participant behaviours or ideas, I regarded the responses included in these categories as conditions that may have contributed to the outcomes of the program for participants. Table 4.5 displays a list of the categories grouped together to form the three main themes and the two categories classified as Other.

<table>
<thead>
<tr>
<th>THEMES (Derived by grouping together categories listed)</th>
<th>CATEGORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLASSROOM PRACTICE</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>Use of Resources</td>
</tr>
<tr>
<td></td>
<td>Assessment Strategies</td>
</tr>
<tr>
<td></td>
<td>Programs</td>
</tr>
<tr>
<td></td>
<td>Changed Practice</td>
</tr>
<tr>
<td>PROFESSIONAL ATTRIBUTES</td>
<td>Confidence</td>
</tr>
<tr>
<td></td>
<td>Attitude</td>
</tr>
<tr>
<td></td>
<td>Collegiality</td>
</tr>
<tr>
<td></td>
<td>Experimentation</td>
</tr>
<tr>
<td></td>
<td>Reflection</td>
</tr>
<tr>
<td>KNOWLEDGE AND BELIEFS</td>
<td>Content Knowledge</td>
</tr>
<tr>
<td></td>
<td>Pedagogical Content Knowledge</td>
</tr>
<tr>
<td></td>
<td>Pedagogical Knowledge</td>
</tr>
<tr>
<td>OTHER</td>
<td>Encouragement</td>
</tr>
<tr>
<td></td>
<td>Support</td>
</tr>
</tbody>
</table>

Tables 4.6–4.9 display the developers' responses to Questions 5 and 7 in a way that facilitates comparison between their views of the outcomes for EMIC participants and their views of observable changes in participant behaviour. Tables 4.6–4.8 show the categorised responses grouped together to form each of the three main themes: Classroom Practice; Professional Attributes; and Knowledge and Beliefs. Table 4.9
shows the two categories of responses classified as Other. A discussion of each of these follows.

**Classroom Practice**

Table 4.6 displays the categorised responses that I grouped together to form the theme Classroom Practice. Many of the developers’ ideas included in this theme were categorised as Teaching Strategies. Responses included in this category were associated with teachers’ strategies for teaching mathematics; that is, with their “method[s] of conducting operations” (The Macquarie Dictionary, 1985) during their mathematics teaching. Five of the eight responses related to the outcomes of the program for participants, and 18 of the 27 responses related to observable changes in teacher behaviour, were categorised as Teaching Strategies. As can be seen in Table 4.6, some responses in this category referred to teaching strategies in a general way.

For example two developers wrote that an outcome for participants of the program has been access to “new methods and strategies”. Similarly two developers reported that the “use of a variety of teaching strategies” would be an observable behaviour that might indicate change in teachers’ practice. Other responses were more specific. For example, “use of investigations” and “more discussions and sharing” refer to quite specific teaching strategies.

Another category grouped in the theme Classroom Practice was Assessment Strategies. While no developers referred to assessment strategies in their discussions of the outcomes of EMIC for participants, five of the fourteen developers surveyed suggested that teachers’ “use of [a] variety of assessment tools” would be an observable behaviour that might be indicative of teacher change.

Use of Resources was another category of responses in this theme. One developer wrote that an outcome for EMIC participants has been a “greater knowledge of resources”. The same developer also suggested that an observable change in teacher behaviour might be their “use of a variety of resources”. With regard to these responses I presumed a rather global definition of “resources”, one that included teaching materials and equipment as well as teacher and student references.

Two further categories grouped in the Classroom Practice theme were Programs and Changed Practice. One developer suggested that an outcome for EMIC participants
<table>
<thead>
<tr>
<th>QUESTIONS</th>
<th>RESPONSES (Number of respondents in parentheses)</th>
<th>CATEGORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you consider the outcomes for EMIC participants have been?</td>
<td>• new methods and strategies (2)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• new/increased repertoire of activities (2)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• parental involvement in maths programs (1)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• greater knowledge of resources (1)</td>
<td>Use of Resources</td>
</tr>
<tr>
<td></td>
<td>• more meaningful mathematics programs (1)</td>
<td>Programs</td>
</tr>
<tr>
<td></td>
<td>• changes in teaching practice (1)</td>
<td>Changed Practice</td>
</tr>
<tr>
<td>What observable changes in teacher behaviour do you consider I should look for?</td>
<td>• use of variety of assessment tools (5)</td>
<td>Assessment Strategies</td>
</tr>
<tr>
<td></td>
<td>• use of group work (4)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• use of variety of teaching strategies (2)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• use of problem solving (3)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• more open ended tasks (2)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• more listening and wait time (2)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• use of investigations (1)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• more discussions and sharing (1)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• emphasis on mathematics language and communication (1)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• emphasis on student methods (1)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• parental involvement in mathematics programs (1)</td>
<td>Teaching Strategies</td>
</tr>
<tr>
<td></td>
<td>• use of variety of resources (1)</td>
<td>Use of Resources</td>
</tr>
<tr>
<td></td>
<td>• changes in classroom lessons, planning and organisation (1)</td>
<td>Programs</td>
</tr>
<tr>
<td></td>
<td>• balanced program (1)</td>
<td>Programs</td>
</tr>
<tr>
<td></td>
<td>• include broad content areas of mathematics in planning (1)</td>
<td>Programs</td>
</tr>
</tbody>
</table>
had been the implementation of “more meaningful mathematics programs”, and three observable changes in teacher behaviour concerned with program planning were suggested. The one response categorised as Changed Practice was very general in nature referring simply to “changes in teaching practice” as an outcome for EMIC participants.

There was a strong emphasis on Teaching Strategies among the responses included in this theme. In particular, a large number of observable changes in teacher behaviour related to Teaching Strategies were suggested by the developers. One explanation for this would be the explicit reference to teachers trialing new strategies in the stated aims of the EMIC program, and the consequent inclusion of opportunities for teacher experimentation and reflection related to the use of teaching strategies as a prominent part in the program design. Given that assessment was the focus of a whole workshop of the EMIC program, the large number of responses related to Assessment Strategies is understandable. While there were explicit references to using a wide variety of resources throughout the program, most notably in relation to the between session explorations and the suggested professional readings (see Section 3.2.3), little emphasis was placed on the use of resources as a significant outcome for EMIC participants by the developers surveyed. The broader issues of program planning and general changes in teaching practice raised in some of the developers’ responses were not surprising given the nature and purposes of the EMIC program.

Professional Attributes

The categorised responses that I grouped together to form the theme Professional Attributes are displayed in Table 4.7. Confidence, Attitude and Collegiality were three kinds of Professional Attributes that were emphasised in responses. Five developers suggested that an outcome for EMIC participants had been “increased confidence”, and that “greater confidence” would be an observable change in teacher behaviour indicative of professional growth. The category Attitude included responses directly referring to positive views of mathematics teaching, as well as the associated ideas of enthusiasm, interest, motivation, purpose and enjoyment. Nine developers suggested outcomes for participants associated with attitudes, and four suggested observable changes in participant behaviour related to attitudes. Four developers wrote that increased collegiality was an outcome for participants already evident, and that involvement in the program would lead teachers to engage in collegial activity.

Two further categories that emerged in the developers’ views of observable changes in teacher behaviour were Experimentation and Reflection.
Table 4.7
Outcomes For Participants and Observable Changes in Teacher Behaviour Suggested by the Program Developers and Classified as Professional Attributes

<table>
<thead>
<tr>
<th>QUESTIONS</th>
<th>RESPONSES</th>
<th>CATEGORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What do you consider the outcomes for EMIC participants have been?</strong></td>
<td>• increased confidence (5)</td>
<td>Confidence</td>
</tr>
<tr>
<td></td>
<td>• collegiality (4)</td>
<td>Collegiality</td>
</tr>
<tr>
<td></td>
<td>• more positive view of mathematics teaching (2)</td>
<td>Attitude</td>
</tr>
<tr>
<td></td>
<td>• interest in maths education issues (2)</td>
<td>Attitude</td>
</tr>
<tr>
<td></td>
<td>• enthusiasm (1)</td>
<td>Attitude</td>
</tr>
<tr>
<td></td>
<td>• motivation to adopt new strategies (1)</td>
<td>Attitude</td>
</tr>
<tr>
<td></td>
<td>• sense of purpose (1)</td>
<td>Attitude</td>
</tr>
<tr>
<td></td>
<td>• desire to continue to learn about mathematics teaching (1)</td>
<td>Attitude</td>
</tr>
<tr>
<td></td>
<td>• greater sense of the power of the professional development model (1)</td>
<td>Attitude</td>
</tr>
</tbody>
</table>

| **What observable changes in teacher behaviour do you consider I should look for?** | • collegiality (4) | Collegiality |
| | • greater confidence (3) | Confidence |
| | • more experimentation (2) | Experimentation |
| | • positive attitude (1) | Attitude |
| | • enthusiasm (1) | Attitude |
| | • more enjoyment for teachers and students (1) | Attitude |
| | • willingness to reflect on own practice (1) | Reflection |
| | • further professional reading (1) | Attitude |
| | • empowerment (1) | Confidence |
| | • involvement in decision making at school level (1) | Confidence |

Direct links between the developers’ responses that were grouped together to form the theme Professional Attributes and several of the stated aims of the EMIC program (see Section 3.2.3) can be noted. In particular, explicit reference to confidence, collegiality, experimentation, and reflection is made in the aims. Further, components
of the program design provide opportunities for teachers to develop these kinds of Professional Attributes (see Section 3.2.3).

Knowledge and Beliefs

Categories of responses grouped together to form the theme Knowledge and Beliefs are displayed in Table 4.8. I used the ideas of Shulman (1986, 1987) related to teacher knowledge as an organising framework for categorising responses that I considered were associated with teachers' knowledge of, and beliefs about, mathematics and the teaching and learning of mathematics. Those responses related specifically to teachers' knowledge and beliefs about mathematics were categorised Content Knowledge. Responses that related to teachers' professional understandings about the teaching and learning of mathematics were categorised Pedagogical Content Knowledge. Responses related to understandings about the curricular alternatives available for teaching mathematics were categorised Curricular Knowledge. Responses related to broad principles and strategies of classroom management and organisation were categorised as Pedagogical Knowledge. In developing these categories I regarded knowledge and beliefs to be inextricably linked and therefore I deliberately made no attempt to distinguish between the two.

As displayed in Table 4.8, most of the developers' views of the outcomes of EMIC for participants, and observable changes in teacher behaviour, were categorised as Pedagogical Content Knowledge. In total, there were ten responses in this category, while only two responses were in the Content Knowledge category, two were in the Curricular Knowledge category and one was in the Pedagogical Knowledge category.

There were few common responses in this theme. Three developers suggested that an outcome for participants had been a "broader view of mathematics teaching". Two developers noted a "better understanding of how mathematics is learnt" to be an outcome, while two developers wrote that an observable change in teacher behaviour would be "greater understanding of mathematics concepts". Each of the other responses included in this theme were made by only one developer.

The developers' strong focus on EMIC participants developing or changing their pedagogical content knowledge is understandable given the aims and content of the EMIC program. As described in Section 3.2.3, the program was focused on pedagogical issues.
Table 4.8
Outcomes For Participants and Observable Changes in Teacher Behaviour Suggested by the Program Developers and Classified as Knowledge and Beliefs

<table>
<thead>
<tr>
<th>QUESTIONS</th>
<th>RESPONSES (Number of respondents in parentheses)</th>
<th>CATEGORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you consider the outcomes for EMIC participants have been?</td>
<td>• broader view of mathematics teaching (3)</td>
<td>Pedagogical Content Knowledge</td>
</tr>
<tr>
<td></td>
<td>• better understanding of how mathematics is learnt (2)</td>
<td>Pedagogical Content Knowledge</td>
</tr>
<tr>
<td></td>
<td>• better understanding of mathematics (1)</td>
<td>Content Knowledge</td>
</tr>
<tr>
<td></td>
<td>• new ways of viewing mathematics teaching (1)</td>
<td>Pedagogical Content Knowledge</td>
</tr>
<tr>
<td></td>
<td>• conceptual framework to organise ideas about mathematics learning (1)</td>
<td>Pedagogical Content Knowledge</td>
</tr>
<tr>
<td></td>
<td>• some instructional models [for teaching mathematics] (1)</td>
<td>Pedagogical Content Knowledge</td>
</tr>
<tr>
<td></td>
<td>• theory to support classroom practice (1)</td>
<td>Pedagogical Content Knowledge</td>
</tr>
<tr>
<td></td>
<td>• allowing students to take responsibility for their learning (1)</td>
<td>Pedagogical Knowledge</td>
</tr>
<tr>
<td></td>
<td>• increased awareness of a range of desirable teaching strategies (1)</td>
<td>Pedagogical Content Knowledge</td>
</tr>
<tr>
<td></td>
<td>• greater knowledge of resources (1)</td>
<td>Curricular Knowledge</td>
</tr>
</tbody>
</table>

| What observable changes in teacher behaviour do you consider I should look for? | • greater understanding of mathematics concepts (2) | Content Knowledge |
|                                                                                | • removal of irrelevant/ inappropriate content (1) | Curricular Knowledge |
|                                                                                | • reference to coherent model of mathematics learning (1) | Pedagogical Content Knowledge |
|                                                                                | • movement towards child-centred approach (1) | Pedagogical Content Knowledge |
|                                                                                | • catering for all abilities (1) | Pedagogical Content Knowledge |
Other

Table 4.9 displays two further categories of responses that emerged in the analysis of the question: what do you consider the outcomes for EMIC participants have been? These responses were not specifically related to any of the three main themes previously discussed. Rather than being outcomes relating specifically to participant behaviours or ideas, they were more like conditions that contributed to the outcomes for participants. For example, one developer suggested an outcome for participants had been “official sanction to explore new methods”. I considered that rather than this being an outcome in itself, it was a condition that might, for example, have encouraged participants to develop Professional Attributes such as confidence and experimentation. I regarded the three responses displayed in Table 4.9 in this way.

Table 4.9

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTION</td>
<td>RESPONSES (Number of respondents in parentheses)</td>
</tr>
<tr>
<td>What do you consider the outcomes for EMIC participants have been?</td>
<td>• official sanction to explore new methods (1)</td>
</tr>
<tr>
<td></td>
<td>• reinforcement of good practice (1)</td>
</tr>
<tr>
<td></td>
<td>• support from the tutor (1)</td>
</tr>
</tbody>
</table>

Data from Questions 8 and 9

Five broad themes emerged when analysing the developers’ views of factors that have had a positive or negative impact on the effectiveness of the EMIC program. These were: Program Structure and Components; Development of the Program; Program Tutors; Professional Development Culture; and School Level Support. One response that was not specifically related to one of these themes was listed as Other. Table 4.10 displays the positive and negative factors suggested by the developers.

As can be seen in Table 4.10, positive factors associated with the program structure and components that were emphasised included time, collegiality, and
<table>
<thead>
<tr>
<th>THEMES</th>
<th>POSITIVE FACTORS (Number of respondents in parentheses)</th>
<th>NEGATIVE FACTORS (Number of respondents in parentheses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROGRAM STRUCTURE AND COMPONENTS</td>
<td>extended nature of program (4)</td>
<td>inadequate time between sessions for classroom explorations (1)</td>
</tr>
<tr>
<td></td>
<td>organised sharing of explorations and good ideas (4)</td>
<td>insufficient time during sessions for teachers to share outcomes of classroom explorations (1)</td>
</tr>
<tr>
<td></td>
<td>collegiality (3)</td>
<td>jargon emphasised at expense of practical examples (1)</td>
</tr>
<tr>
<td></td>
<td>networking (2)</td>
<td>lack of concept development, sequence ... teachers' own understanding of mathematics (1)</td>
</tr>
<tr>
<td></td>
<td>classroom explorations (2)</td>
<td>tries to do too much (1)</td>
</tr>
<tr>
<td>DEVELOPMENT OF PROGRAM</td>
<td>skills and knowledge of original authors (2)</td>
<td>individual &quot;hobby horses&quot;/ &quot;barrows to push&quot; of rewrite team (3)</td>
</tr>
<tr>
<td></td>
<td>extensive trialling process (1)</td>
<td>change in direction when program rewrite occurred (1)</td>
</tr>
<tr>
<td></td>
<td>program refined over time (1)</td>
<td>bureaucratic factors related to management of program (1)</td>
</tr>
<tr>
<td></td>
<td>quality of illustrative instructional activities (1)</td>
<td>lack of central support after 1989 (1)</td>
</tr>
<tr>
<td></td>
<td>quality of presentation of materials (1)</td>
<td>decrease in funding (1)</td>
</tr>
<tr>
<td>PROGRAM TUTORS</td>
<td>tutor support; tutors working with teachers (4)</td>
<td>less effective/&quot;watered down&quot; tutor training from 1989 (2)</td>
</tr>
<tr>
<td></td>
<td>extensive tutor training program (3)</td>
<td>absence of statewide conferences for all tutors from 1989 (1)</td>
</tr>
<tr>
<td></td>
<td>provision of support for tutors at regional and state levels (3)</td>
<td>quality and lack of charisma of tutors (1)</td>
</tr>
<tr>
<td></td>
<td>classroom teachers as tutors (2)</td>
<td>insufficient formal background in mathematics education of tutors (1)</td>
</tr>
<tr>
<td></td>
<td>quality and charisma of tutor (1)</td>
<td>push by some tutors to provide smorgasbord of activities (1)</td>
</tr>
<tr>
<td></td>
<td>enthusiasm and dedication of tutor (1)</td>
<td>some tutors de-emphasise professional readings (1)</td>
</tr>
<tr>
<td></td>
<td>experience of tutor in group management (1)</td>
<td></td>
</tr>
<tr>
<td>PROFESSIONAL DEVELOPMENT CULTURE</td>
<td>perceived need by teachers for help in mathematics (1)</td>
<td>associated &quot;flavour-of-the-month mentality&quot;; EMIC as a quick fix (1)</td>
</tr>
<tr>
<td></td>
<td>provides what teachers think they want (1)</td>
<td>belief that participation in EMIC a must (1)</td>
</tr>
<tr>
<td></td>
<td>other numeracy programs (1)</td>
<td>not a continuing theory; &quot;done&quot; after session 10 (1)</td>
</tr>
<tr>
<td></td>
<td>other professional development (1)</td>
<td>after program teachers unsure what it means for their own practice (1)</td>
</tr>
<tr>
<td></td>
<td>perceived link to career development/promotion (1)</td>
<td>some participants do not have initial enthusiasm/commitment (1)</td>
</tr>
<tr>
<td>SCHOOL LEVEL SUPPORT</td>
<td>support of school administration (1)</td>
<td>lack of support across school (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>culture of mathematics classrooms and schools does not reinforce messages in EMIC (1)</td>
</tr>
<tr>
<td>OTHER</td>
<td>nice afternoon tea (1)</td>
<td></td>
</tr>
</tbody>
</table>
experimentation. Significantly, nine responses related to issues of collegiality and the professional sharing of ideas. Few negative factors associated with program structure and components were suggested.

With regard to factors associated with the development of the program, the quality of the program activities and materials were identified as having a positive impact on the program’s effectiveness, while political issues related to the management, support and funding of the program were recognised by several respondents as obstacles to the program’s success. A division between the views of developers associated with the different versions of the program can be noted in the responses included in this theme. For example, two developers (Developers 4 and 8—both involved in the development of the original version of the program) stated that the skills and knowledge of the original authors had a positive impact on the program’s effectiveness, and three developers (Developers 1, 4, and 14—who all had some involvement in the original and revised versions) expressed concern about the negative impact of the individual “hobby horses” of those involved in the program rewrite. Contrasting, and even opposing views of changes to the program were obvious in several responses. For example, one developer suggested that changes to the program as it was “refined over time” (Developer 13, p. 3) had a positive impact on the effectiveness of EMIC, whilst another suggested that the “changed direction” of the program when the rewrite occurred had a negative impact on the program (Developer 5, p. 3).

The role of the program tutor was emphasised in responses. Fifteen responses related to the positive impact of the tutor role on the program’s effectiveness. In particular, the support role provided through tutors working with teachers was highlighted as a critical factor in the program’s success. Also the extensive training of the tutors and the support provided to them as they worked as tutors was considered by several respondents to be important. Some developers noted the “watering down” of the tutor training program from 1989, and the absence of support for tutors around this time to have had a negative impact on the success of EMIC.

Factors associated with the nature and purpose of professional development were also emphasised in responses. Three developers suggested that teachers’ perceptions of EMIC in relation to meeting their professional needs had a positive impact on the program’s effectiveness. Two developers suggested that associations with other professional development activities positively influenced the effectiveness of EMIC. Four factors were suggested to have had a negative impact on the program’s effectiveness. These related to what the developers described as the “quick-fix” and
discontinuous nature of the professional development, the imposed pressure on some participants to participate in the program, and the difficulties associated with applying the ideas presented in the professional development program.

Further factors identified as impacting on the effectiveness of the program related to school level support. The provision of support for EMIC participants at the school level was seen by one developer as having a positive impact on the program's effectiveness, while lack of support at this level was suggested to have a negative effect on the program outcomes.

As I had expected, the data most useful for achieving the purposes of the questionnaire were drawn from the developers' responses of their views of the program outcomes. Responses associated with the three main themes of Classroom Practice, Professional Attributes, and Knowledge and Beliefs, and positive and negative factors influencing the effectiveness of EMIC, were used to guide the development of a tentative framework for considering teacher development in Phase Two of the study. This framework is described in Section 4.5.

4.4.4 The developers' views of potential changes to the program

Responses to Question 10, which asked the developers to describe changes they would have made to the program if they were writing it at the time the questionnaire was distributed, were varied with few respondents stating similar ideas. For this reason they were simply organised into two categories: general suggestions and specific recommendations. Table 4.11 displays the two categories of responses.

I found no particular use for this data in this study. While I had originally anticipated that this question would provide an opportunity for the developers to reflect and report on different elements of the program, the changes recommended by the developers were either very specific, or quite global in nature, and they were particularly disparate. As such, they did not prove useful for my research purpose in this phase of the study.
Table 4.11
Recommended Changes to the EMIC Program Suggested by the Program Developers

<table>
<thead>
<tr>
<th>GENERAL SUGGESTIONS (Number of respondents in parentheses)</th>
<th>SPECIFIC RECOMMENDATIONS (Number of respondents in parentheses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• more continuous and coherent to improve overall messages and flow of units (1)</td>
<td>• communicate model of learning and role of language in more practical terms (2)</td>
</tr>
<tr>
<td>• include electives (e.g. technology, girls and mathematics, etc.) (1)</td>
<td>• improve section on Integrated Curriculum (2)</td>
</tr>
<tr>
<td>• involve participants more in the direction of the course (1)</td>
<td>• give assessment and evaluation a higher profile (1)</td>
</tr>
<tr>
<td>• build in more flexibility for presenters and potential for negotiation with participants (1)</td>
<td>• introduce assessment techniques progressively throughout the program (1)</td>
</tr>
<tr>
<td>• introduce more adult learning experiences (1)</td>
<td>• reschedule the assessment unit to Unit 10 (1)</td>
</tr>
<tr>
<td>• more emphasis on planning balanced programs (1)</td>
<td>• more emphasis on technology, estimation, mathematical modelling (1)</td>
</tr>
<tr>
<td>• make allowances for continuing growth after 10 sessions (1)</td>
<td>• change the program focus to address teachers’ own understandings of mathematics (1)</td>
</tr>
<tr>
<td>• develop follow-up to EMIC to apply EMIC ideas to body of interesting content (1)</td>
<td>• select one area of focus rather than a bit of everything (1)</td>
</tr>
<tr>
<td>• encourage EMIC graduates to enrol in further studies (1)</td>
<td>• focus the last 2 sessions on what the ideas presented mean for classroom practice (1)</td>
</tr>
<tr>
<td></td>
<td>• slightly fewer activities and more time for discussion (1)</td>
</tr>
</tbody>
</table>

4.5 The framework for investigating teacher professional growth in Phase Two

Data collected from the EMIC Developers Questionnaire informed the development of a tentative framework for investigating the specific research questions that guided this study (see Section 3.1.3).

Data related to the developers’ views of the program aims, objectives and expected outcomes (see Sections 4.4.2 and 4.4.3), along with the stated aims of the program, were useful for developing a structure to guide the investigation of the research question: what change do primary teachers report and demonstrate in practice when they participate in a mathematics professional development program? In particular, I used these data to construct an overview of likely outcomes of an “ideal” EMIC program. This overview is displayed as Table 4.12. It comprised three “components of teacher change”. These were: Classroom Practice; Professional Attributes; and Knowledge and Beliefs. Within each component I identified associated teaching
Table 4.12
Overview of Outcomes of an "Ideal" EMIC Program

<table>
<thead>
<tr>
<th>COMPONENTS OF TEACHER CHANGE</th>
<th>ASSOCIATED TEACHING BEHAVIOURS, KNOWLEDGE AND BELIEFS (Increased: range of/degree of)</th>
<th>AIMS OF THE EMIC PROGRAM RELATED TO EACH COMPONENT</th>
</tr>
</thead>
</table>
| CLASSROOM PRACTICE          | Teaching Strategies Use of Resources Assessment Strategies                      | • consider current developments in mathematics education  
                                |                                                  | • try out and consider adopting new teaching/learning strategies  
                                |                                                  | • investigate the role of parents in supporting children's mathematics development |
| PROFESSIONAL ATTRIBUTES     | Confidence Attitude Collegiality Experimentation Reflection                        | • gain confidence as mathematics teachers  
                                |                                                  | • share and work cooperatively together  
                                |                                                  | • try out and consider adopting new teaching/learning strategies  
                                |                                                  | • reflect on current practice as teachers of mathematics |
| KNOWLEDGE AND BELIEFS       | Content Knowledge Pedagogical Content Knowledge Pedagogical Knowledge            | • consider current developments in mathematics education  
                                |                                                  | • increase awareness of how children learn mathematics |

behaviours, knowledge and beliefs. These components, and their associated teaching behaviours, knowledge, and beliefs, were derived from the data categories developed to analyse the developers’ views of the program outcomes. I selected from those data categories the teaching behaviours and knowledge and beliefs that were also prominent in the EMIC program aims and purposes. Links between the components and the stated aims of the EMIC program are highlighted through the inclusion of the related aims in the third column of Table 4.12.

Fundamental to the overview presented in Table 4.12 was the view that teachers involved in an ideal EMIC program would demonstrate change in each component. With regard to the Classroom Practice component, I identified three associated areas of teaching behaviour in which teachers might demonstrate change. These were: Teaching Strategies; Use of Resources; and Assessment Strategies. In general terms, I considered that the EMIC program would increase teachers’ repertoires of teaching and assessment strategies, and encourage them to make use of a diverse range of resources in their mathematics programs. The inclusion of Assessment Strategies and Use of Resources as important areas in this component is justified not only because they
featured in the responses of some of the EMIC developers, but also because they were key areas in the written materials provided in the EMIC program.

Five areas associated with the Professional Attributes component were identified. I considered that, in relation to their mathematics teaching, participants of an ideal EMIC program would become more confident and positive, engage in collegial activity, and engage in experimentation and reflection.

Three areas related to the component of Knowledge and Beliefs were identified. I considered that an ideal EMIC program would provide teachers with opportunities to develop knowledge in the areas of Pedagogical Knowledge, Pedagogical Content Knowledge and Content Knowledge, and to reflect on (and possibly change) their beliefs associated with these areas—that is, their beliefs about mathematics and mathematics teaching and learning.

After reviewing the data related to each component, I decided initially that I would focus the investigation of teacher change in Phase Two of this study on the component of Classroom Practice. I selected the Classroom Practice component as I considered that its associated teaching behaviours could be more easily observed than the associated teaching behaviours, knowledge and beliefs of the other components. I decided to use the three areas of teaching behaviour (Teaching Strategies, Use of Resources and Assessment Strategies) to frame the observations of teacher participants in their classrooms during mathematics teaching sessions, and the discussions in the structured interview process used in the second phase of the study. Drawing directly on the developers’ responses, I refined my focus for each of these areas further to specifically consider teacher participants’ awareness and use of a variety of teaching strategies, resources, and assessment strategies.

While I used the component of Classroom Practice to develop a basic framework for determining the initial data to collect, I deliberately designed the data collection tools to be flexible, to ensure that emergent themes could be investigated throughout the study. This flexible approach to the data collection proved critical in this study. As the study progressed, the focus shifted from teacher change to teacher growth, and it became evident that teacher growth could not be described adequately with reference to a teacher’s Classroom Practice alone. As a consequence, I decided to extend the study to encompass a richer description of teacher growth by also considering areas associated with teachers’ Professional Attributes and Knowledge and Beliefs.
Data related to the EMIC developers' views of positive and negative factors influencing the effectiveness of the program provided a useful structure for guiding the investigation of the second research question in this study: what factors associated with mathematics professional development programs do teachers perceive as influencing their professional growth? Five categories emerged when analysing the developers' views of positive and negative factors influencing the program effectiveness. These were: Program Structure and Components; Development of the Program; Program Tutors; Professional Development Culture; and School Level Support. To investigate the factors associated with professional development programs that teachers perceived as influencing their professional growth in Phase Two, I developed interview questions associated with these areas. These will be described in the next chapter.

In summary, the data collected and analysed in this phase provided a strong foundation for focusing the initial investigation of teacher change and the subsequent investigation of teacher growth in the second phase of the study. In the next chapter, details related to the data collection and the process of data analysis in Phase Two of the study are provided.
Chapter 5
Phase Two: Investigating teacher professional growth—
The process

This chapter describes the process used to examine teacher professional growth in the second phase of this study. First, the selection of the particular Exploring Mathematics In Classrooms (EMIC) course and subjects is described. Next, details related to the data collection and the data analysis are presented. Finally, the purpose for, and process of, collecting and analysing data from the EMIC tutor is discussed.

5.1 Selecting an EMIC course and subjects

5.1.1 Selecting an EMIC course

When selecting an EMIC course for investigation in this study, two factors were considered important. These were the identification of a course conducted by a tutor recognised for her/his competence, and the location of a course that was suitable logistically.

I considered the role of the tutor to be a critical factor in identifying an appropriate EMIC course. The importance of the tutor role has been given some recognition in the research literature (see for example, Fenstermacher & Berliner, 1985; Sparks & Loucks-Horsley, 1990; Wildman & Niles, 1987). It was also highlighted by the EMIC program developers in their responses to the EMIC Developers Questionnaire (see Chapter 4). Therefore a major criteria I used in selecting a course was that it was conducted by a tutor who was regarded as both capable and credible, and who was a teacher who demonstrated the desired outcomes of the program in their own classroom.

I reviewed the courses that were scheduled at appropriate times and locations, and made a selection based on the suitability of the course’s logistical arrangements, and the suitability of the course tutor’s demonstrated teaching practice. With respect to the latter, I consulted with two Victorian Ministry of Education Numeracy Reference Group committees. These committees were responsible for the coordination of EMIC tutors and courses in their Regions. I met with each committee and presented an outline of my research proposal, emphasising my research purposes and the important
role I considered that the tutor played in the delivery of EMIC. The committees then provided a list of courses that were to be conducted by tutors who they regarded as both capable and credible, and I selected a tutor and course from those recommended.

A variety of internal Ministry of Education factors beyond my control, or the control of the committees providing the recommendations, made the timing of this procedure very difficult. For example, once I had selected the course for investigation, I had only a few weeks prior to the commencement of the course to seek the formal approval needed for the study and to identify the study participants.

The course I selected commenced in April 1991. It was conducted in the Southern Metropolitan Region of the Victorian Ministry of Education, at the school where the tutor was based. There were 27 participants from seven local schools involved. This was an unusually large participant group for an EMIC course, catering for more participants than is suggested in the EMIC Participant’s Logbook (Ministry of Education, 1990a). However, the situation had been negotiated with the tutor, who was an experienced EMIC tutor and felt comfortable with this group size.

I gained approval to study this particular course from the Victorian Ministry of Education through the Southern Metropolitan Region’s General Manager. The course tutor enthusiastically agreed to be involved in the research, and the Principal of the school where the tutor was based supported her involvement.

5.1.2 Selecting the teachers

The procedure I adopted for selecting teachers to be involved in this study was directly related to the research purposes. My focus was on understanding the process of teacher growth for participants in an EMIC program, and so my interest was in what Stake (1995) referred to as “particularization”:

The real business of case study is particularization, not generalization. We take a particular case and come to know it well, not primarily as to how it is different from others but what it is, what it does. There is emphasis on uniqueness, and that implies knowledge of others that the case is different from, but the first emphasis is in understanding the case itself. (p. 8)

Therefore rather than being concerned with statistical sampling procedures that would lead to the collection and use of data for generalising findings, the procedure I used was based on “purposeful” considerations (Miles & Huberman, 1994; Patton, 1990; Wiersma, 1991). In particular I used criteria of “balance and variety” in selecting
teacher participants for this study as I considered that a selection based on these
criteria would provide the best "opportunity to learn" in this context (Stake, 1995,
p. 6).

Initially I selected a group of six teachers from a list of participants provided by the
course tutor. The group included teachers from three different schools and a range of
class year levels. However, when I requested their assistance, most of the teachers I
had selected were not able or not prepared to become involved as participants in the
study due to a variety of personal and professional reasons.

Course participant information was first available to me only two weeks before the
course was due to commence. I was therefore unable to repeat the process of
identifying, contacting and gaining approval for a second group of study participants
prior to the commencement of the course. This meant that I was forced to develop an
alternative plan for identifying participants for the study.

I decided to make a direct request for involvement in the study to the EMIC
participants at the initial session of the course. At that session I found six teachers
prepared to be involved in the research. Approval for their participation was then
sought from, and granted by, the Manager of Southern Metropolitan Region, and each
of the teacher's Principals.

Table 5.1 displays details of the participants involved in the study. The six teachers
came from four different schools and had a range of teaching experience from 4 to 18
years. All six teachers had experience in "generalist" classroom teaching, and five
teachers had experience in "specialist" teaching roles (Anne, Alan, Brian, Cath and
Debra). In Victoria, generalist teachers teach all curriculum areas and specialists have
responsibility for particular areas. Typically specialist areas might include library,
physical education, music and art, and less typically, mathematics. Anne had been a
specialist library teacher, while Alan had been a library and physical education
specialist. Brian had been a specialist physical education teacher and had also had
additional responsibilities for teaching science and applied mathematics. Cath had
been a specialist in computer education and science in primary schools, and had also
taught mathematics at Grades 7 and 8. Debra had worked as a special education
teacher. The group included four females and two males. Two sets of teachers came
from the same school (Anne and Alan—School A, Beth and Brian—School B), one
teacher (Cath) was one of two teachers involved in the course from School C, and
another teacher (Debra) was the only staff member from School D involved in the
Table 5.1  
Overview of Study Participants

<table>
<thead>
<tr>
<th>PARTICIPANT</th>
<th>SCHOOL</th>
<th>YEARS TEACHING</th>
<th>GRADE LEVELS TAUGHT DURING THE PERIOD OF THIS STUDY</th>
<th>GRADE LEVELS PREVIOUSLY TAUGHT</th>
</tr>
</thead>
</table>
| ANNE        | A      | 15             | Grade 3                           
 |             |         |                             | Grade 1/2            | 2, 3, 4, 5, 6, & specialist roles Prep–6 |
| ALAN        | A      | 15             | Grade 4/5                         
 |             |         |                             | Grade 3              | Prep, 1, 2, 3, 4, 5, 6, & specialist roles Prep–6 |
| BETH        | B      | 4              | Grade 4                           
 |             |         |                             | Grade 4/5        | 1, 3, 4, 5, 6          |
| BRIAN       | B      | 9              | Grade 4/5                         
 |             |         |                             | Grade 5/6           | 4, 5, & specialist roles Prep–6 |
| CATH        | C      | 17             | Grade 4/5                         
 |             |         |                             | Grade 5/6           | Prep, 1, 2, 3, 4, 5, 6, & specialist roles Prep–6 |
| DEBRA       | D      | 18             | Grade Prep                         
 |             |         |                             | Grade Prep         | Prep, 1, 2, 3, 4, & specialist roles Prep–6 |

course. Two of the participants came from the school where the course was being conducted, and where the tutor was situated (Anne and Alan—School A).

Although my initial attempt at purposeful sampling was unsuccessful, as displayed in Table 5.1, the group of teachers involved in the study nevertheless represented a range of experience, schools and grade levels.

5.2 Data collection

The process of data collection in this phase of the study evolved and developed as the study proceeded. Initially I planned a broad framework for the data collection, including the specification of particular tools and a timeline of their proposed use. My intention was to use this framework as a guide for deciding the type and amount of data to be collected at different points in time during this phase. I used this framework as a starting point for the data collection, planning in detail initial observation and interview schedules. However, I anticipated that as I collected and analysed the data, my ideas about the kinds of data that would be most useful and the best ways to obtain that data would develop and change. I therefore adopted a flexible approach, using the initial framework as a broad reference and developing the specific details of the tools as the study proceeded.
An overview of the data collection tools developed and the timeframe of the data collection process follows. A detailed description of the nature of the data collected is then presented.

### 5.2.1 Overview of the tools and timeframe

A variety of data gathering techniques was used in this phase of the study to enable a detailed description of the professional growth of the six EMIC participants in relation to their mathematics teaching.

Observations and interviews were the primary data sources. I conducted observations of the teachers working in their classrooms over the 18 month period of this phase. I also made observations of several of the EMIC sessions in which they participated. I involved each teacher in several interviews. Some of these were structured interviews involving a predetermined sequence of open-ended questions. Others were informal conversational interviews that involved questions relevant to the immediate context. I also used a questionnaire and collected sample work documents from the teachers. These provided additional sources of information. A large body of data was collected from the teachers.

In addition to collecting data from the six teacher participants, I also gathered data from the tutor of the EMIC course investigated. I used structured and informal interviews to collect data from the tutor.

The different data collected were recorded in a variety of forms. These included: a structured observation record sheet; fieldnotes; interview audio tapes and transcripts; written responses to the questionnaires; and sample teaching documents. Table 5.2 provides an overview of the different tools used to gather data in this phase of the study and the form in which they were recorded. Each of these are discussed in detail in Section 5.2.2.

The different tools displayed in Table 5.2 were used at particular times in this phase of the study for specific purposes. Table 5.3 summarises the process of data collection in the three time periods of this phase of the study and the purposes of this data collection. Details of the nature of the data collected follow.
Table 5.2
Overview of the Phase Two Data Collection Tools and Data Record Forms

<table>
<thead>
<tr>
<th>DATA COLLECTION TOOLS</th>
<th>DATA RECORD FORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBSERVATIONS</td>
<td></td>
</tr>
<tr>
<td>- individual classroom</td>
<td>observation records</td>
</tr>
<tr>
<td>- EMIC sessions</td>
<td>field notes</td>
</tr>
<tr>
<td>INTERVIEWS</td>
<td></td>
</tr>
<tr>
<td>- structured</td>
<td>audio tapes/transcripts</td>
</tr>
<tr>
<td>- informal</td>
<td>field notes</td>
</tr>
<tr>
<td>TEACHER QUESTIONNAIRE</td>
<td>written responses</td>
</tr>
<tr>
<td>TEACHING DOCUMENTS</td>
<td>planning documents</td>
</tr>
<tr>
<td>TUTOR INTERVIEWS</td>
<td></td>
</tr>
<tr>
<td>- structured</td>
<td>audio tape/transcript</td>
</tr>
<tr>
<td>- informal</td>
<td>field notes</td>
</tr>
</tbody>
</table>

Table 5.3
Overview of the Phase Two Data Collection Process

<table>
<thead>
<tr>
<th>TIME PERIOD</th>
<th>DATA COLLECTION</th>
<th>PURPOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DURING THE EMIC PROGRAM</td>
<td>• Structured interview 1</td>
<td>• To gather baseline data against which change and growth could be identified</td>
</tr>
<tr>
<td></td>
<td>• Classroom observations 1 &amp; 2</td>
<td>• To observe the participants’ initial response to the EMIC program, including the exploration of program ideas in their mathematics teaching practice</td>
</tr>
<tr>
<td>April–August 1991</td>
<td>• Sample teaching document 1</td>
<td>• To identify factors that may influence the professional growth of the teachers</td>
</tr>
<tr>
<td></td>
<td>• EMIC program observations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Informal interviews</td>
<td></td>
</tr>
<tr>
<td>SOON AFTER THE EMIC PROGRAM</td>
<td>• Structured interview 2</td>
<td>• To gather information related to any demonstrated or perceived change in the participants’ mathematics teaching practice</td>
</tr>
<tr>
<td>September 1991–April 1992</td>
<td>• Classroom observations 3, 4, 5 &amp; 6</td>
<td>• To identify factors that may influence the professional growth of the teachers</td>
</tr>
<tr>
<td></td>
<td>• Teacher questionnaire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Sample teaching document 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Informal interviews</td>
<td></td>
</tr>
<tr>
<td>10–12 MONTHS AFTER THE EMIC PROGRAM</td>
<td>• Structured interview 3</td>
<td>• To determine whether any long lasting change was demonstrated in teachers’ practice, or reported by them</td>
</tr>
<tr>
<td>May–September 1992</td>
<td>• Classroom observations 7 &amp; 8</td>
<td>• To identify factors that may have influenced the professional growth of the teachers over time</td>
</tr>
<tr>
<td></td>
<td>• Sample teaching document 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Informal interviews</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Tutor questionnaire</td>
<td></td>
</tr>
</tbody>
</table>
5.2.2 Nature of the data

Observation data

I planned eight classroom observations for each participant over the course of the study. However, due to professional and logistical constraints (for example teacher promotions, school transfers and long service leave), two teachers (Alan and Cath) could only be observed seven times, and one teacher (Brian) was observed in a classroom setting only five times. Table 5.4 displays the number of classroom observations I conducted for each teacher across the time periods of the study.

Table 5.4
Number of Classroom Observations for Teacher Participants

<table>
<thead>
<tr>
<th>NAME</th>
<th>DURING EMIC</th>
<th>SOON AFTER EMIC</th>
<th>10-12 MONTHS AFTER EMIC</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANNE</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>ALAN</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>BETH</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>BRIAN</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>CATH</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>DEBRA</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

The main foci of the classroom observations were teaching behaviours related to the component of Classroom Practice discussed in Chapter 4. These were: Teaching Strategies; Use of Resources; and Assessment Strategies. I developed and trialed a number of methods of observing and recording information related to each of these areas, before finalising a flexible observation record sheet to record the details of the classroom observations. A sample of this observation record sheet has been included as Appendix 1. It displays details of the second observation in Alan’s classroom which took place in the period During the EMIC Program.

The classroom observation record sheet comprised five different sections for recording information. These included sections for recording:
- details of the session observed (including teacher identification, date, grade level, number of students, lesson topic or focus, and lesson duration);
• a description of the physical setting of the session observed (including a grid for a sketch map of the classroom set-up);
• an outline of the procedure of the session observed (including a grid based on main segments of the lesson);
• teacher behaviours related to the three areas of Classroom Practice—Teaching Strategies, Use of Resources and Assessment Strategies (including grids for each area); and
• "notes" of other significant observations.

I considered that, in combination, data in these areas could provide an appropriate picture of the context of the teaching session, and the selected Classroom Practice teaching behaviours.

The grids developed to record observations of each of the areas of Classroom Practice are displayed in Figure 5.1.

![Figure 5.1. Sample Observation Record Sheet Classroom Practice Grids.](image-url)

The grids displayed in Figure 5.1 varied in design and, as it turned out, effectiveness. The Use of Resources and Assessment Strategies grids proved to be the most difficult to design and the most problematic to use. These grids were made up of categories specific to each one. The Use of Resources grid included the following resource types: commercial publications (for example: commercial mathematics program books and worksheets; miscellaneous teacher books; children's literature); school based
publications (for example: units of work; worksheets; charts; problem solving boxes); mathematics teaching and learning equipment and materials (for example: attribute blocks; fraction kits; MAB; trundle wheels); and other (general) equipment and materials (for example: newspapers, magazines and catalogues; boxes and packages; string, streamers and tape). The Assessment Strategies grid included the following types of strategies for measuring or assessing student performance: observations; questioning and interviews; student work samples; student journals; self assessment; and tests. It further specified strategies for recording assessment information. These included: anecdotal records; checklists; and student portfolios. I considered these categories to represent the full range of possible resource use and assessment strategy types, and I anticipated that the recording of information at this category level would provide a sufficient amount of detail and an efficient means of recording my observations. However, even though I had completed observations in order to develop, trial and refine the grids, when I began to observe the study participants in their classrooms, I felt a need to add more detail than these grids allowed. For example, I found myself making notes next to the Resources grid of the particular kinds of mathematics teaching and learning equipment and materials being used, and I noted next to the Assessment grid when self assessments were completed by individual students or groups of students. Thus the observation record sheets inevitably contained notes that provided information much richer in detail than those I had first anticipated recording.

The Teaching Strategies grid was, from the beginning, more open in its design in an attempt to capture the richness and subtle variation of individual teacher's practice. I felt that this could best be done through descriptive comment rather than by the use of a predetermined (and inevitably restrictive) set of categories. The grid comprised a section to record the type of teaching strategies employed and a section to record notes related to the selection and use of teaching strategies. My intention was to progressively record all teaching strategies used and later categorise them. In hindsight, I believe that a similar open design would have worked as effectively for the two other areas of the Classroom Practice component: Use of Resources and Assessment Strategies.

Each of the grids displayed on the observation record sheet was divided into three sections to represent different teaching segments in the classroom lessons (see Figure 5.1). Initially I had intended that each section would represent one third of the total time period observed. However as I began my observations I found it more useful to use these sections to record observations of different lesson segments. These
segments were based on the nature of the classroom activity rather than on a direct
division of the lesson time. The first segment often involved some kind of introductory
activity, the second often involved exploration or application, and the third segment
often involved discussion and reflection related to the topic. Variations to this format
which sometimes occurred were easily noted on the lesson procedure grid. I also
recorded specific times for the different segments on that grid to enable me to monitor
the time associated with each one.

Soon after commencing the classroom observations I recognised the need to also
consider teacher behaviours, and ideas related to teacher knowledge and beliefs,
associated with the Professional Attributes and Knowledge and Beliefs components of
teacher change (see Chapter 4). I recorded information related to these components in
the form of descriptive comments on the observation record sheets. These comments
guided my further exploration of these components in the interviews and the
questionnaire, and in the teaching documents analysis.

In addition to the classroom observations, I also observed four EMIC workshops and
recorded incidental observations in fieldnotes during these. The purpose of these
observations was to note comments the teachers made with respect to their
exploration of, and reflection on, the EMIC program ideas.

The observations throughout the study provided me with opportunities to develop
insights into the teachers' mathematics teaching practice, their preparedness to trial
new or alternative mathematics teaching strategies introduced in the EMIC program,
and their ideas related to mathematics teaching and learning.

**Interview data**

Each teacher was involved in three structured interviews as well as several informal
and spontaneous interviews over the study period.

The structured interviews were held at the commencement of the EMIC program, soon
after the program had finished, and twelve months after the completion of the
program. They provided opportunities to collect detailed information related to the
teachers' views of their professional growth in regards to their mathematics teaching.
They also provided a systematic means for relating the teachers' ideas with those I
observed in the classroom observations and the EMIC workshops.
I developed, trialed and prepared interview schedules for each structured interview, copies of which are included as Appendix 2. Each interview schedule had a common format which consisted of five key sections:

1. **Background**—this section sought background information related to the teaching and professional development experiences of the teachers.

2. **Overview of mathematics teaching**—this section sought information related to the teachers’ views of their mathematics teaching practice (in general), including any “recent” changes in that practice.

3. **Key areas of Classroom Practice**—this section sought information related to the teachers’ views of their practice specifically with regard to the three areas of Classroom Practice: Teaching Strategies; Assessment Strategies; and Use of Resources. Across the time of the study teachers were asked to specify their perceptions of the impact of EMIC on these areas.

4. **Mathematics in the school**—in this section the teachers’ views of mathematics teaching in their schools were sought.

5. **The EMIC program**—this final section sought the teachers’ views of the likely impact of the EMIC program, and their views of the positive and negative features of the program.

An overview of the content of these sections for each interview is presented in Table 5.5. While there were no specific sections in the interview format related to the Professional Attributes and Knowledge and Beliefs components of teacher change, I was able to explore these areas in the teachers’ responses to questions throughout the different sections of the interviews.

I carefully worded and arranged the questions in each interview section, as it was my intent to take each participant through the same open-ended question sequence. I chose to develop open-ended questions to minimise the imposition of predetermined responses (Patton, 1990), and I chose to carefully sequence the questions in order to obtain data that were systematic and thorough for each respondent. I further considered that the structuring of the interview in this way would enable the effective analysis of the data as I could efficiently locate and organise respondents’ answers to the same questions.
<table>
<thead>
<tr>
<th>INTERVIEW SECTION</th>
<th>INTERVIEW NUMBER</th>
<th>FOCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. BACKGROUND</td>
<td>1</td>
<td>• general teaching experience, and mathematics teaching experience</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>• experience of the EMIC program</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>• other recent professional development experience</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>• further experiences associated with the EMIC program</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>• other recent professional development experience</td>
</tr>
<tr>
<td>2. OVERVIEW OF MATHEMATICS TEACHING</td>
<td>1</td>
<td>• perceptions of current practice</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>• perceptions of current practice</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>• perceptions of changes</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>• perceptions of current practice</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>• perceptions of changes</td>
</tr>
<tr>
<td>3. KEY AREAS OF CLASSROOM PRACTICE</td>
<td>1</td>
<td>• current strategies</td>
</tr>
<tr>
<td>- Teaching Strategies</td>
<td>2</td>
<td>• sources of teaching ideas</td>
</tr>
<tr>
<td>- Use of Resources</td>
<td>2</td>
<td>• initial impact of EMIC</td>
</tr>
<tr>
<td>- Assessment Strategies</td>
<td>3</td>
<td>• perceived changes in practice</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>• perceived changes in practice</td>
</tr>
<tr>
<td>4. MATHEMATICS IN THE SCHOOL</td>
<td>1</td>
<td>• view of mathematics teaching in the school</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>• view of relationship between ideas presented in EMIC and mathematics teaching in the school</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>• impact of involvement in EMIC on mathematics teaching in the school</td>
</tr>
<tr>
<td>5. THE EMIC PROGRAM</td>
<td>1</td>
<td>(not applicable)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>• view of the EMIC program</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>• view of the impact/value of EMIC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• future directions for involvement in professional development</td>
</tr>
</tbody>
</table>

Each structured interview was audio-taped and fully transcribed. Because my concern was with the overt content of the interview responses and not with the emotive detail of respondent enthusiasm or anger for instance, it was generally sufficient to transcribe only the spoken words. However, where it was judged that an affective element of the
response supported one interpretation over another, this was duly noted. A set of
sample interview transcripts for Alan has been included as Appendix 3.

I also involved the teachers in informal and spontaneous interviews at various times
throughout the study, as a need or opportunity arose. These conversational interviews
allowed me to flexibly pursue information in whatever direction appeared appropriate
or emerged in a particular setting at a particular time. Such conversations permitted
me to develop understandings of the teachers’ reactions to what was happening in
their classrooms with regard to their mathematics teaching, and also the tutor’s
understandings of what was happening in the professional development program and
in her work with the teachers. The data collected in these informal interviews was
different for each participant in the study. This proved to be both interesting and, at
times, challenging. For example, these conversations were useful for seeking
elucidations and elaborations from participants. However, while I felt that I learnt a
lot about some teachers during these times (with seemingly little effort), I found that it
was difficult to get others to elaborate. I recorded teacher comments made in informal
interviews in fieldnotes.

**Questionnaire and teaching documents data**

A questionnaire was given to each teacher participant approximately six months after
they completed the EMIC program. The purpose of the questionnaire was to collect
further data on the participants’ views of their mathematics teaching practice.

The questionnaire, which is displayed in a reformatted form as Table 5.6, consisted of
six short answer questions which encouraged teachers to reflect on their involvement in
the EMIC program and their current mathematics teaching practice. The questions
were modelled on the IMPACT procedure developed by D.J. Clarke (1989). I felt that
this procedure, which is essentially concerned with learners reflecting on the outcomes
of their learning, could be appropriately modified to encourage the teachers in this
study to reflect on their professional development experience.
Table 5.6
EMIC Teacher Participant Questionnaire (reformatted)

<table>
<thead>
<tr>
<th>QUESTION NUMBER</th>
<th>QUESTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Write down two important things you have learnt about mathematics teaching and learning from your participation in EMIC.</td>
</tr>
<tr>
<td>2</td>
<td>Write down at least one thing about teaching mathematics which you have continued to find difficult.</td>
</tr>
<tr>
<td>3</td>
<td>What would you most like more information about/assistance with in regards to teaching mathematics?</td>
</tr>
</tbody>
</table>
| 4               | How do you feel about your mathematics teaching at the moment? (Circle the words that apply to you)  
|                 | a) interested  b) relaxed  c) worried  
|                 | d) successful  e) confused  f) happy  
|                 | g) bored  h) rushed  i) frustrated  
|                 | j) Write down a word of your own _________ |
| 5               | What is the biggest worry affecting your work in teaching mathematics at the moment? |
| 6               | How could you improve your mathematics teaching? |

I used the questionnaire responses to assist cross-validation of the data collected. The questionnaire provided an opportunity for teacher participants to reflect on, and comment on, their mathematics teaching and their professional growth without me present. A copy of the questionnaire completed by Alan has been included as Appendix 4.

I collected teaching documents from the teachers throughout the study to provide additional information related to their program planning. These included samples of teachers' written planning documents from the different time periods of the study, sample teaching materials and worksheets, and student work samples. The set of teaching documents collected from Alan has been included as Appendix 5. While some of these documents were interesting, they did not prove useful with respect to providing additional insights in this study.

5.3 Data analysis techniques

5.3.1 Data organisation and display

The process of data analysis was interwoven with the data collection in this phase. Analysis began when the first data were collected and it continued after the final data
were gathered. The purposes of the data analysis were to understand the data that had already been collected, and, in part, determine what data to seek next (Neuman, 1997).

Initially, I found the process of designing analysis techniques challenging, and at times frustrating. This was because although I read about qualitative analysis in the research literature, and sought advice from other researchers involved in qualitative inquiry, I found few specific guidelines to inform my work. I found instead, that there is no "particular" or "right" way of doing qualitative analysis. I also found that while descriptions of different techniques are given in research method texts, the processes associated with the design of specific analysis techniques are not often explained.

Considering these difficulties, I decided first, that in order to design appropriate analysis techniques I needed a thorough knowledge of the data collected. For this purpose I examined the data by looking at it and reading it many times until I felt I knew it well. Second, I organised and reorganised the data in many different ways until I felt that I understood it. For example, I organised the data in computer files and visual displays. During this extensive process of exploration I developed the specific techniques for analysing the data collected. In particular, I developed a data coding and classification system and different kinds of data displays. A description of these follows. I subsequently used a theoretical model to represent the teachers' professional growth. The use of this theoretical model is discussed in the next section of this chapter.

It should be noted that the analysis techniques outlined below were used to examine all of the data collected for each of the six teachers involved in the study. Illustrative examples of data codes and data displays are provided as Appendices.

**Data coding and classification**

I developed a detailed coding and classification system to examine all data that were collected and stored as text during the study. This included interview, questionnaire and fieldnotes data. The classification system I used in this phase was developed in the same way as the system used to analyse the EMIC Developers Questionnaire in Phase One (see Section 4.3). The process of coding and classifying the text data provided opportunities to examine that data from many different perspectives.

The categories used to analyse the interview, questionnaire and fieldnotes data initially related closely to areas associated with the Classroom Practice component of teacher change (Teaching Strategies, Use of Resources and Assessment Strategies), and to
characteristics of professional development programs. However, as I examined and explored interview transcripts, questionnaire responses and fieldnotes, I developed additional categories as new themes and issues arose. This process proved to be quite elaborate. For example, when a “new” category was created, I had to consider its relationship to other categories including whether or not it was a completely new idea and whether it should subsume, or be subsumed by, any other categories. Once I had decided to use a new category I then had to apply it to the complete set of text data.

The categories finally decided on were grouped together to form four main themes. These related to the three components of teacher change (Classroom Practice, Professional Attributes, and Knowledge and Beliefs) and to characteristics of professional development programs. Table 5.7 displays a complete listing of the categories included within each theme.

The initial categories and codes that I developed are displayed in the second and third columns of Table 5.7. Further associated categories and codes developed during my examination of the text data are displayed in the fourth column. While it would be impractical here to provide a detailed description of the 43 different categories developed, relevant discussions of the findings of the data coding and classification process will be presented in Chapters 6, 7, 8 and 9. In addition, illustrative examples of categorised text files have been included as Appendix 6 and Appendix 7.

Data displays

Across the time of the study I developed a variety of different data displays. The definition of data displays that I adopted was that proposed by Miles and Huberman (1994):

By display we mean a visual format that presents information systematically, so the user can draw valid conclusions and take needed action. (p. 91)

Miles and Huberman (1994) reported several benefits of using displays:

the chances of drawing and verifying valid conclusions [from displays] are much greater than for extended text, because the display is arranged coherently to permit careful comparisons, detection of differences, noting of patterns and themes, seeing trends, and so on. (p. 92)
### Table 5.7
**Themes and Categories Developed to Examine the Text Data**

<table>
<thead>
<tr>
<th>THEMES</th>
<th>INITIAL CATEGORIES</th>
<th>INITIAL CODES</th>
<th>FURTHER ASSOCIATED CATEGORIES &amp; CODES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CLASSROOM PRACTICE</strong></td>
<td>Teaching Strategies</td>
<td>CP/TCH</td>
<td>Teaching Approach - CP/TCH/APP&lt;br&gt;Teaching Experience - CP/TCH/EXP&lt;br&gt;Teaching Content - CP/TCH/CON&lt;br&gt;Teaching Ideas Source - CP/TCH/ISO</td>
</tr>
<tr>
<td></td>
<td>Use of Resources</td>
<td>CP/RES</td>
<td>Approach to Using Resources - CP/RES/APP&lt;br&gt;Teacher Resources Available - CP/RES/AV</td>
</tr>
<tr>
<td></td>
<td>Assessment Strategies</td>
<td>CP/ASS</td>
<td>Assessment Approach - CP/ASS/APP&lt;br&gt;Assessment Attitude - CP/ASS/ATT&lt;br&gt;Assessment Purpose - CP/ASS/PUR&lt;br&gt;Assessment Records - CP/ASS/REC</td>
</tr>
<tr>
<td><strong>PROFESSIONAL ATTRIBUTES</strong></td>
<td>Confidence</td>
<td>PA/CON</td>
<td>Mathematics Program Features - PA/CON/PFE</td>
</tr>
<tr>
<td></td>
<td>Attitude</td>
<td>PA/ATT</td>
<td>Enthusiasm - CP/ATT/ENT&lt;br&gt;Enjoyment - CP/ATT/ENJ&lt;br&gt;Interest - CP/ATT/INT</td>
</tr>
<tr>
<td></td>
<td>Collegiality</td>
<td>PA/COL</td>
<td>School Context Information - PA/COL/SCI</td>
</tr>
<tr>
<td></td>
<td>Experimentation</td>
<td>PA/EXP</td>
<td>Knowledge of Innovations - PA/EXP/KIN</td>
</tr>
<tr>
<td></td>
<td>Reflection</td>
<td>PA/REF</td>
<td>Mathematics Program Effectiveness - PA/REF/PEF&lt;br&gt;Mathematics Program Features - PA/REF/FE&lt;br&gt;Mathematics Program Concerns - PA/REF/PCO</td>
</tr>
<tr>
<td><strong>KNOWLEDGE AND BELIEFS</strong></td>
<td>Content Knowledge</td>
<td>KB/ COK</td>
<td>Teaching Ideas Source - KB/CO/ISO</td>
</tr>
<tr>
<td></td>
<td>Pedagogical Content Knowledge</td>
<td>KB/PCK</td>
<td>Knowledge of Innovations - KB/PCK/KIN</td>
</tr>
<tr>
<td></td>
<td>Curricular Knowledge</td>
<td>KB/ CUK</td>
<td>Knowledge of Innovations - KB/ CUK/KIN</td>
</tr>
<tr>
<td></td>
<td>Pedagogical Knowledge</td>
<td>KB/PEK</td>
<td>Knowledge of Innovations - KB/PE/KIN</td>
</tr>
<tr>
<td><strong>PROFESSIONAL DEVELOPMENT PROGRAM CHARACTERISTICS</strong></td>
<td>Professional Development Program Background</td>
<td>PD/PBC</td>
<td>Professional Development Program Expectations - PD/PBC/EXP &lt;br&gt;Professional Development Program Experience - PD/PBC/EXE</td>
</tr>
<tr>
<td></td>
<td>Professional Development Program Characteristics</td>
<td>PD/PCH</td>
<td>Professional Development Program Structure - PD/PCH/STR&lt;br&gt;Professional Development Program Content - PD/PCH/CON&lt;br&gt;Professional Development Program Presentation - PD/PCH/PRE</td>
</tr>
</tbody>
</table>
The data displays that I developed served two main purposes:

- they allowed the same data to be organised and considered in different ways according to the particular research purpose being addressed (for example, change specific to individual teachers, change specific to each area of Classroom Practice, change specific to the different time periods of the study);
- they provided opportunities to identify links between changes demonstrated by teachers during classroom observations and changes reported by teachers during the interviews and questionnaire.

A description of the key stages involved in developing the data displays in this study follows.

Several displays specific to the different data types were developed early in the study. These included displays specific to the observation data, the interview data and the questionnaire data. Examples of these have been included as Appendices 8, 9 and 10 respectively. Appendix 8 displays a matrix of interview responses that was recorded on A3 paper to enable different teachers’ responses to be viewed at the same time (this display was reduced in size for inclusion as an appendix). Matrices like these were developed for each of the three structured interviews. Appendix 9 displays a categorised listing of all of the resources used by the teachers in the different time periods, and a chart showing the total number of resources used by each teacher. Similar displays were prepared with respect to Teaching Strategies and Assessment Strategies. Appendix 10 displays the teachers’ questionnaire responses, organised according to questions, and with memos recorded in the margins. These early displays were particularly useful for “getting-to-know” the data.

Further displays of interview and observation data were developed later in the study. Appendices 11, 12 and 13 display excerpts from three tables of teachers’ interview responses, organised according to the different areas of Classroom Practice: Teaching Strategies, Resource Use, and Assessment Strategies. The tables show the kinds of comments each teacher made in relation to the different areas of Classroom Practice in the different time periods of the study. The excerpts included in these appendices specifically show Alan’s responses. Similar tables were developed to display each teacher’s interview responses related to the other components of teacher change: Professional Attributes and Knowledge and Beliefs. Appendices 14 and 15 display excerpts from these tables—in particular, they show Alan’s responses. In addition, a similar table was developed to display the interview data related to characteristics of
professional development programs perceived by the teachers as influencing professional growth. This table has been included as Appendix 16.

Appendices 17, 18 and 19 display observation data related to Teaching Strategies, Resource Use and Assessment Strategies respectively. These displays show the kinds and number of strategies and resources used by the teachers in the classroom lessons observed. They also show the total number of teachers who used each strategy and resource type.

In addition to displays that were specific to the different data types, multi-data-source displays were also developed. These enabled links and patterns between the different data to be viewed. Appendices 20, 21 and 22 provide examples of these multi-data-source displays. They show information related to Alan's Teaching Strategies, his Resource Use, and his Assessment Strategies respectively. Each one displays classroom observation data, interview data and questionnaire data relevant to each of the study time periods.

The organisation and presentation of the data in these many display forms facilitated analysis of the data. Many of the displays described above were used in the process of representing teacher growth (additional displays developed during this process are discussed in the next section). A description of the theoretical model used in this study to represent teacher growth follows.

5.3.2 Using the Interconnected Model of Teacher Professional Growth to represent teacher growth

The Interconnected Model of Teacher Professional Growth (Teacher Professional Growth Consortium, 1994) was used to interpret and represent the empirical data collected in this study, and consequently to facilitate understanding of the process of growth experienced by the teachers involved in the study.

In order to understand how the Interconnected Model was used for this purpose, several terms associated with the model need clarification. The following discussion is intended to provide clarification of these terms as they are applied in this study. Figure 5.2 displays the Interconnected Model for reference during this discussion. For ease of reference throughout this thesis a copy of the Interconnected Model has been included as the final appendix—Appendix 27.
The Interconnected Model is a model of teacher professional growth that deals specifically with the process of change. In particular, the model is concerned with change in four domains, and the mechanisms by which change in one domain is associated with change in another (Teacher Professional Growth Consortium, 1994). The four domains are analogous (but not identical) to the four domains identified by Guskey (1986).

There are two types of domains represented in the Interconnected Model. The External Domain (represented in the square in Figure 5.2), is distinguished from the other domains (represented in circles in Figure 5.2), by its location outside of the teacher's personal world. The model implies that the Domain of Practice, the Personal Domain and the Domain of Consequence encapsulate the personal world of the teacher.

The model implies that a "change" can be located in one of the four domains. A change in information provided by an external source can be located in the External Domain. A change in practice, knowledge or belief can be located in one of the other three domains: the Domain of Practice, the Personal Domain, or the Domain of Consequence (see Figure 5.2). The type of change in a teacher's practice, knowledge or belief will reflect the specific domain. For example, experimentation with a new
teaching strategy would reside in the Domain of Practice, new knowledge or a new belief would reside in the Personal Domain, and a changed perception of salient outcomes related to classroom practice would reside in the Domain of Consequence.

The model suggests that change in one domain can result in change in another through the mediating processes of "reflection" and "enaction". The Teacher Professional Growth Consortium (1994) chose the term enactment to distinguish the translation of a belief or a pedagogical model into action from that of simply acting. They reported that "acting occurs in the Domain of Practice, and each action represents the enactment of something a teacher knows, believes or has experienced" (Teacher Professional Growth Consortium, 1994). The mediating processes of reflection and enactment are represented in the model as arrows linking the domains.

Both reflection and enactment can take various forms. In earlier versions of the Interconnected Model (for example see D.J. Clarke & Peter, 1993), the Domain of Consequence was called the Domain of Inference. The use of the term "inference" was intended to stress the importance of teacher interpretation as the mechanism by which change in the Domain of Practice is associated with an inferred change in outcomes in the Domain of Consequence. For example, teacher experimentation involving increased student talk may be interpreted by one teacher as a change in classroom noise level, and by another teacher as a change in student engagement. Since the same overt social behaviour is open to such disparate interpretation, it is the interpreted change, rather than any observable change, that is crucial to subsequent change in teacher knowledge and beliefs. Teacher interpreted change is the only consequence of teacher experimentation that is "of consequence" either to the teacher or to the researcher seeking to explain changes in teacher knowledge and beliefs. Consistent with D.J. Clarke and his colleagues in the Teacher Professional Growth Consortium (1994), the term "Domain of Consequence" is used throughout this thesis. Readers of this thesis should not confuse the teachers' inferred consequences with any observable changes to teacher or student outcomes.

During this study, the process by which change in two or more domains occurs, is represented using the Interconnected Model by denoting particular "change sequences". A change sequence consists of two or more domains together with the reflective or enactive links connecting these domains, where empirical data supports both the occurrence of change in each domain and their causal connection. For example, if a teacher was exposed to a new teaching strategy at an EMIC session and decided to
explore the use of that strategy in their classroom, the change sequence displayed in Figure 5.3 would be used to represent that change.

![Diagram](image)

*Figure 5.3. Sample change sequence.*

In Figure 5.3, it is implied that a change in the External Domain (the introduction of a new teaching strategy during an EMIC session) has been translated through the mediating process of enactment (represented by the arrow) into a change in the Domain of Practice (experimentation with the new teaching strategy in class).

Importantly, it should not be assumed that a change sequence is evidence of professional "growth". In this study, the term growth is reserved for enduring or lasting change, and there may be sequences of change that do not appear to have any lasting effect on a teacher. However, where data have demonstrated the occurrence of lasting change, then this lasting change is taken to signify professional growth. The change sequence(s) associated with this professional growth will then be termed a "growth network". For example the teacher who explored the new teaching strategy referred to in Figure 5.3, may have reflected on the consequences of that exploration and decided that two notable outcomes were improved student learning and increased satisfaction with respect to their teaching. This may have led to a change in belief regarding the use of the strategy, and consequently the inclusion of the strategy as a regular part of the teacher's practice. This would be considered an example of teacher growth. Figure 5.4 displays the growth network associated with the teacher's growth in this case. Arrow 1 represents the teacher's initial exploration (or enactment) of the strategy they were exposed to at EMIC. Arrow 2 represents the teacher's
interpretation (upon reflection) as to what constituted the outcomes of that exploration. Arrow 3 represents the teacher's evaluative reflection on the salient outcomes, which led to a change in belief. Arrow 4 represents the application of the new belief (via enactment) as a regular feature of the teacher's practice.

![Diagram](image)

*Figure 5.4. Sample growth network.*

It is important to note that, in this study, teacher professional growth is viewed through the goals of the EMIC program. In Phase One of the study, the views of the EMIC program developers and the documented aims of the program were analysed to determine foci for examining the professional growth of EMIC teacher participants. These foci were described as areas of a teacher's "Classroom Practice". The particular Classroom Practice areas used as the foci to examine teacher growth in Phase Two of the study are Teaching Strategies, Resource Use and Assessment Strategies. Within this context, teacher professional growth is seen to be directly linked to the intent of the EMIC program. With this in mind, it is possible to conceive of three different forms of potential growth related to this study. These growth types can broadly be characterised as:

*Adoption*—where there is lasting change in teacher practice and/or beliefs that is in line with the ideas presented in the EMIC program (for example, encouraging student talk about mathematics during lessons);

*Misrepresentation*—where there is lasting change in teacher practice and/or beliefs, however the change has developed through a misinterpretation of the ideas presented in EMIC (for example, adopting the use of a resource recommended in EMIC, however using it in a manner that was not intended—for instance teachers
might regard activities from the resource MCTP [Mathematics Curriculum and Teaching Program] as "fun" Friday afternoon maths tasks, rather than as examples of exemplary lessons from which they might develop their own good teaching ideas; and

Rejection—where there is lasting change in teacher beliefs which is directly related to the rejection of the ideas presented in the EMIC program (for example, trying a cooperative group learning task, deciding that it leads to a loss of classroom control, and rejecting it as a useful strategy for teaching mathematics).

Only those practices or beliefs associated with "adoption" are considered to be examples of growth, as it is defined in this study.

In summary, the Interconnected Model is used in this study to represent change sequences and growth networks. In particular, it is used to represent:

• the domains in which there was evidence of change for the teachers;
• the links between domains where there was evidence of change; and
• the cumulative combination of change sequences that represent the teachers’ growth—that is, their growth networks.

Examples of the kinds of displays developed during the process of analysing the data in order to represent teacher growth using the Interconnected Model have been included as Appendices 23, 24 and 25. These appendices display teachers’ change sequences on diagrammatical representations of the model, with respect to Teaching Strategies, Resource Use, and Assessment Strategies respectively.

Each of the analysis techniques I developed in this phase were guided in design by patterns and themes that emerged in the collected data (Ely, 1991; Huberman & Miles, 1984; Miles & Huberman, 1994; Patton, 1990; Tesch, 1990). I used the coding and classification system, and the various data displays developed, together with the Interconnected Model to:

• examine themes that emerged in the study;
• make links between the data and the literature; and
• provide a framework for reporting the findings of the study.

5.4 Collection and analysis of data from the EMIC tutor

The EMIC tutor was involved in several spontaneous and informal interviews, as well as a structured interview during the study. These interviews provided opportunities to
collect data related to the tutor's views about the EMIC program and the professional growth of the teacher participants.

The EMIC tutor worked closely with the teacher participants not only during the EMIC workshop sessions, but also in their school and classroom settings as she provided support throughout the program, and following it. Through her support role, she was in a position to closely observe the teachers as they explored ideas presented in the program.

On several occasions during the program and following it, the tutor would comment on activities the teachers were exploring, strategies they were experimenting with, and her observations of some teachers' increased enthusiasm and participation in the mathematics communities within their schools. I recorded comments made by the tutor during such informal interviews in field notes.

I also developed a structured interview to collect data specifically related to the tutor's observations of the teachers' professional growth, and her views of characteristics of the EMIC program that facilitated or inhibited teacher growth. One particular area of interest that emerged from the analysis of the data collected from the teachers in the study was the influence of the program tutor on their professional growth. Several of the teachers regarded the tutor role to be significant in their professional growth, so this became a focus area for further investigation in the tutor interview developed.

I decided that the tutor interview should be conducted in the period twelve months after the EMIC program had concluded, so that the tutor would have had opportunities to observe the teachers' reactions to the program following its completion. I developed and trialed a number of questions with other EMIC tutors. The questions finally decided on were organised into four sections. These related to:

- the tutor's role;
- the EMIC program in general;
- the professional growth of the six teachers involved in this study; and
- professional development in general.

During the period of development of the interview, however, the tutor announced that she had applied for a Voluntary Redundancy Package from the Victorian teaching service and would be departing for England. This situation created a need to develop an alternative form of data collection as it was considered unsuitable to travel to England to conduct the interview, or to use phone facilities.
I decided to mail the tutor a refined list of thirteen interview questions and two audio tapes for her to record responses to the questions, as if being interviewed. The questions are displayed in Table 5.8.

<table>
<thead>
<tr>
<th>QUESTION SECTIONS</th>
<th>QUESTION NUMBER</th>
<th>QUESTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUESTIONS RELATED TO</td>
<td>1</td>
<td>Describe how you saw your role as an EMIC tutor.</td>
</tr>
<tr>
<td>THE TUTOR’S ROLE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>What do you consider are the positive features of your style of working</td>
</tr>
<tr>
<td></td>
<td></td>
<td>with teachers during EMIC courses?</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>How might your style of working as an EMIC tutor differ from</td>
</tr>
<tr>
<td></td>
<td></td>
<td>others?</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>What factors outside your control do you believe influenced your</td>
</tr>
<tr>
<td></td>
<td></td>
<td>effectiveness as an EMIC tutor?</td>
</tr>
<tr>
<td>QUESTIONS RELATED TO</td>
<td>5</td>
<td>What do you think are the key elements of the EMIC program?</td>
</tr>
<tr>
<td>THE EMIC PROGRAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Do you see the EMIC program as successful? Why/why not?</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Could you describe other professional development programs you</td>
</tr>
<tr>
<td></td>
<td></td>
<td>have been involved with. In your opinion, what are the similarities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and differences between EMIC and these programs, both in terms of the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>programs and their relative success?</td>
</tr>
<tr>
<td>QUESTIONS RELATED TO</td>
<td>8</td>
<td>Of the six teachers I worked with (Anne, Alan, Beth, Brian, Cath,</td>
</tr>
<tr>
<td>THE PROFESSIONAL</td>
<td></td>
<td>the least? Why do you think this?</td>
</tr>
<tr>
<td>GROWTH OF THE SIX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEACHERS INVOLVED IN THIS STUDY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>What teacher characteristics are likely to influence the impact of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the EMIC program?</td>
</tr>
<tr>
<td>QUESTIONS RELATED TO</td>
<td>10</td>
<td>What do you think are the criteria for effective professional</td>
</tr>
<tr>
<td>PROFESSIONAL DEVELOPMENT IN</td>
<td></td>
<td>development programs?</td>
</tr>
<tr>
<td>GENERAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>How would you evaluate the success of a professional development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>program?</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Who do you see as the beneficiaries of a professional development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>program?</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>If someone said to you they were studying teacher change, what do</td>
</tr>
<tr>
<td></td>
<td></td>
<td>you think they would be studying?</td>
</tr>
</tbody>
</table>

The tutor recorded her responses over a period of a week, made a copy of the tape for mailing security purposes which she kept, and then returned the original to me. The
tape was then fully transcribed to enable analysis of the tutor's responses. This alternative data collection technique provided an effective solution to this problematic situation, and in fact several advantages over standard interview practices emerged from this experience. First, as the tutor indicated in an accompanying letter, she was able to peruse the list of questions and thoughtfully consider her response to each one prior to speaking on the tape. This enabled her to feel more comfortable about her responses and less pressured to have to recall exactly what was being asked. Second, the tutor could stop the tape at any time, think further about a question, and then add more details as she felt necessary. This encouraged the tutor to give more detailed responses than she would have in a standard interview situation. Third, the method was cost effective in comparison with travel expenses or telephone charges. Finally, the method proved particularly time effective.

A copy of the transcribed tutor interview has been included as Appendix 26. I wrote descriptive memos on different sections of the transcript. Some memos related to themes that emerged in the analysis of the data collected from the teachers. Others emerged directly from the tutor's responses.

I used different sections of the tutor interview transcript in reporting findings of the study related to the professional growth of individual teachers, and to characteristics of professional development programs that influence professional growth.

In the following four chapters, the findings of this second phase of the study are reported. Chapter 6 provides a detailed account of the story of one teacher, Alan. Chapter 7 reports the stories of the other five teachers. Chapter 8 provides an overview of the outcomes demonstrated and reported with respect to the teachers' change and growth. And, Chapter 9 describes the teachers' perceptions of characteristics of professional development programs influencing teacher growth.
Chapter 6
Phase Two: Examining teacher professional growth—The story of Alan

In this chapter, the professional growth of one teacher, Alan, is examined. Analyses of the data related to Alan’s Classroom Practice are presented, and the Interconnected Model of Teacher Professional Growth is used to represent Alan’s growth in this area across the time of the study.

The detailed description of Alan’s professional growth presented in this chapter is illustrative of the process used to examine the professional growth for each of the six teachers involved in the study. In the following two chapters summaries of the professional growth of the other teachers are presented, and similarities and differences in the teachers’ growth are explored.

6.1 The structure for reporting Alan’s professional growth

The purpose of this chapter is to provide a detailed account of Alan’s professional growth across the time of the study with respect to his Classroom Practice—in particular, his Teaching Strategies, Resource Use, and Assessment Strategies. Details of how Alan changed with respect to classroom experimentation (Domain of Practice), knowledge and beliefs (Personal Domain), and classroom-related outcomes (Domain of Consequence), are examined.

The account of Alan’s professional growth is presented in four sections. These sections describe:

- contextual details of his professional history, environment and inclinations [Section 6.2];
- his Classroom Practice in each of the distinct time periods of the study: During the EMIC Program, Soon After the EMIC Program, and 10–12 Months After the EMIC Program [Section 6.3];
- his professional growth across the time of the study [Section 6.4]; and
- critical factors associated with his professional growth [Section 6.5].
Throughout the chapter, classroom observation data, interview data and questionnaire data are used to identify particular change sequences associated with Alan's professional growth, in particular with respect to the three components of Classroom Practice. Diagrammatic representations of the Interconnected Model are used to represent these change sequences and subsequent growth networks. Illustrative examples of these diagrams, and an explanation of how to "read" them, are presented below.

In the diagrams presented throughout this and the following chapters:

- the titles of the Domains are abbreviated as follows:
  - EXT—External Domain
  - PRAC—Domain of Practice
  - CONS—Domain of Consequence
  - PERS—Personal Domain;
- arrows indicate the mediating processes of enactment and reflection linking the domains—thick arrows represent enactment and thin arrows represent reflection; and
- each component of Classroom Practice is represented by different coloured arrows—blue represents Teaching Strategies, yellow represents Resource Use, and pink represents Assessment Strategies.

These diagrammatic features can be noted in Figures 6.1 and 6.2, which display sample diagrams used in the discussion of the study period, "Soon After the EMIC Program".

![Figure 6.1. Change sequences applicable to Alan Soon After the EMIC Program with respect to Resource Use.](image)
Figure 6.1 displays one of Alan’s change sequences with respect to Resource Use (represented by yellow arrows). In “reading” Figure 6.1, it can be inferred that Alan:

- was exposed to some new strategy with respect to resource use at EMIC (represented by the External Domain);
- explored the new resource use strategy in practice (represented by arrow 1—the [thick] enactment arrow linking the External Domain and the Domain of Practice);
- reflected on his use of that strategy (represented by arrow 2—the [thin] reflection arrow linking the Domain of Practice and the Personal Domain); and
- sought some further external information or stimulus associated with this resource use strategy (represented by arrow 3—the [thick] enactment arrow linking the Personal Domain and the External Domain).

In the discussions of Alan’s Classroom Practice throughout this chapter, specific data examples are used to identify these kinds of change sequences. Similar diagrams are also used to display Alan’s growth networks with respect to each component of Classroom Practice examined.

Figure 6.2 presents an overview of all of Alan’s change sequences in the period Soon After the EMIC Program. Arrows have not been numbered in Figure 6.2 as the combined data was too complex to be ordered in any simple fashion. However, since it was Alan’s participation in EMIC that acted as the stimulus for the changes which are empirically documented in Figure 6.2 (and the other Figures in this chapter), arrows emanating from the External Domain (representing new information and ideas) can be assumed to precede other consequent changes represented.

![Figure 6.2. Overview of change sequences applicable to Alan Soon After the EMIC Program.](image-url)
It can be inferred from Figure 6.2 that Alan:

- explored ideas that were presented in the EMIC program with respect to each Classroom Practice component (represented by the [thick] enaction arrows linking the External Domain and the Domain of Practice);
- engaged in much reflection during this period (represented by the [thin] reflection arrows linking: the Domain of Practice with the Domain of Consequence; the Domain of Consequence with the Personal Domain; and the Domain of Practice with the Personal Domain); and
- sought further external information or stimulus with respect to Teaching Strategies and Resource Use (represented by the [thick] enaction arrows linking the Personal Domain and the External Domain).

Diagrams similar to Figure 6.2 are used in the discussions of Alan’s Classroom Practice in each of the study time periods, to provide the reader with an overview of the change sequences associated with Alan’s professional growth.

In order to be able to identify change it is necessary to know about Alan’s professional context. Accordingly, in the next section, contextual details of Alan’s teaching background are presented.

### 6.2 Alan in context

Since this research uses case study as its dominant methodology, it is essential that sufficient contextual detail is provided for each teacher’s professional growth to be understood in terms of their:

- professional history;
- professional environment; and
- professional aspirations and inclinations.

This section presents these contextual details for Alan.

#### 6.2.1 Teaching background

At the commencement of the study Alan had 15 years teaching experience in primary schools. As a classroom teacher he had taught all grade levels (Prep [K] to Grade 6), and he had worked in physical education and librarian specialist teaching roles.
When he became involved in the EMIC program, Alan was in his first year teaching at School A and was working with a composite Grade 4/5 class. In the second year of the study, he taught Grade 3 at the same school.

During structured interviews and informal discussions, Alan explicitly articulated his passion for teaching.

I really enjoy teaching. I love it. ... I've always enjoyed it and I'm really positive about it. (Alan, Interview 1, p. 7)

6.2.2 School context

At the beginning of the year during which the study commenced, Alan was a new member of staff at School A. The school, which was located in a southern inner suburb of Melbourne, had a student population of around 300, and 12 full time teaching staff.

The EMIC program was based at School A, where the EMIC tutor was a member of staff. All members of the teaching staff, aside from Alan and one other teacher, Anne, had previously participated in EMIC.

The mathematics ethos at the school was positive and strong. Under the leadership and guidance of the EMIC tutor, who was also the mathematics curriculum coordinator, staff and students frequently engaged in whole school mathematics activities, and mathematics as a learning area appeared to have a high profile within the school. Students' mathematics work was often displayed throughout the school, formal exhibitions of student work in mathematics were conducted for parents and the wider community, and professional development and extra curricular activities in mathematics were conducted regularly. The attitude of staff towards the teaching and learning of mathematics was observed to be particularly enthusiastic and positive.

6.2.3 Alan's view of his mathematics teaching prior to EMIC

Based on what Alan reported during interviews throughout the study, his mathematics teaching prior to his participation in the program could be broadly characterised as "traditional"; that is, teacher directed and textbook focused. During Interview 1, conducted at the commencement of the study, Alan made comments that reflected this orientation in relation to each of the components of Classroom Practice examined.
Teaching Strategies

The description Alan provided of his teaching style during Interview 1 was consistent with traditional teaching approaches. He stated that typically he would "go over" the mathematics content to be covered with the whole class using a blackboard demonstration (Alan, Interview 1, p. 4).

Alan stated that he was not aware of any innovative techniques with respect to mathematics teaching, and he attributed that lack of awareness to the fact that he had "been out of the classroom" for several years working in specialist teaching roles. He anticipated that his participation in EMIC would provide him with current teaching ideas.

That's one of the reasons for me going to EMIC—to find out some of the things that are happening [in mathematics education].
(Alan, Interview 1, p. 4)

When asked about specific kinds of teaching strategies that he used for teaching mathematics, Alan made reference to a few that he had explored. In particular he spoke of his use of problem solving activities, mathematics games, and home tasks.

They might play games. And, problem solving—we've done some really good problem solving activities this year with the children. ... I actually like to occasionally give the children a mathematical problem to take home as homework that they can solve with their parents. I try to do that as much as I can to allow the parents to become involved and do something with their children. (Alan, Interview 1, p. 5)

Resource Use

During Interview 1, Alan reported that he liked to use a range of different sources of teaching ideas. He made reference to a number of commercial publications that were available to him, and to the school's well equipped maths room. He also acknowledged the "people support" available within his school. In particular he noted the support of Tanya, his colleague and the EMIC program tutor.

With Tanya, you don't really need anyone [else].
(Alan, Interview 1, p. 3)

Alan also commented briefly in this interview about his use of equipment and materials.

I have some things available [for student use] like Unifix—mainly Unifix and MAB. And if we're doing practical stuff then whatever we need for that particular lesson. (Alan, Interview 1, p. 6)
Alan's comments regarding his use of resources during Interview 1 tended to be fairly general in nature. He provided little detail as to how he actually used resources to plan his teaching, or how he used them in his work with students. Comments Alan made later in the study indicated that, prior to his involvement in EMIC, he was limited in his awareness of available resources, and in his knowledge of how to use resources effectively. This may account for the lack of detail with respect to Alan's discussion of his use of resources early in the study.

Assessment Strategies

During Interview 1, Alan spoke of his assessment practice as consisting primarily of testing and marking student work using a scoring system. His comments indicated a limited awareness of alternative assessment strategies such as those to which he was to be introduced in the EMIC program.

Well I test whatever I've done. I'm not testing just to get a mark, but as a measure of what the children know and what I need to repeat. (Alan, Interview 1, p. 6)

Well if I'm going to do something where I give them a score out of ten then I record that on a list. ... Only odds and ends like [multiplication] tables—I still think they're important. I do tests on those to see which ones they know. (Alan, Interview 1, p. 6)

Alan appeared to see testing as a means to determining student knowledge in order to inform his teaching.

The purpose of any testing is to find out what the children know and it also helps you evaluate what they know and what they don't know so that you can do something about what they don't know. And also it helps you with teaching. I mean if you teach something and find out that the children haven't grasped the concept that you were trying to teach, obviously you'll need to do something about it. (Alan, Interview 1, p. 6)

One further assessment strategy that Alan mentioned during Interview 1 was student self assessment. He stated that his students "don't assess themselves" (Alan, Interview 1, p. 7).

Inferences regarding Alan's traditional orientation towards his mathematics teaching could also be drawn from some of the reflective statements he made about his previous teaching style during Interviews 2 and 3. These statements will be presented later in the discussions of the periods in which those interviews were conducted.
6.2.4 Involvement in EMIC

Alan was initially coerced into participating in EMIC. Even though during Interview 1 he stated that he was “looking forward to EMIC” because he hadn’t done anything like it for a long time, and also that he felt “a bit outdated” (Alan, Interview 1, p. 7), it became clear during informal discussions with him, and with the program tutor, that there was pressure on him to participate in the program. That pressure took two forms. First, as part of the formal arrangements made between the tutor, School A and the Ministry of Education related to the conduct of the program, two places were reserved for the staff members from School A who had not completed EMIC (Alan and Anne). Second, as all other staff at School A had completed the program, there was some internal pressure within the school for Alan to participate.

Although Alan articulated an awareness of his need for professional development in mathematics, it appeared from comments made following the completion of the program that if he had not been coerced he may not have chosen to participate. During Interview 2 he confessed his initial reluctance towards participating in EMIC.

To start off with the thought of doing it filled me with horror because I studied Thursday nights last year, then this year I did a First Aid course on Thursday nights, and I just finished that and it was into this, and I thought Oh God! Do I need to be doing this? And it was a chore to turn up the first couple of times because I just wanted some time to myself. But it wasn’t that bad. I quite enjoyed it. (Alan, Interview 2, pp. 5–6)

6.3 Alan’s Classroom Practice

This section examines Alan’s Classroom Practice across the time of the study. The discussion is structured around the three distinct time periods of the study: during the EMIC program; soon after the EMIC program; and 10–12 months after the EMIC program. Analyses of the data are used to describe changes with respect to Alan’s Classroom Practice during each time period, and diagrammatic representations of the Interconnected Model are used to represent the change sequences associated with Alan’s professional growth (see Section 6.1 for a description of how to read these diagrams).

During the analysis of the data with respect to changes in practice, knowledge and beliefs of all six teachers involved in the study (see Chapter 5), a pattern emerged which suggested that particular change sequences were associated with all of the
teachers' professional growth in the different time periods of the study. These particular change sequences associated with the different study periods are used in this chapter, and in Chapter 7 to broadly categorise the nature of the teachers' change. The period during the EMIC program is characterised by "exploration". The period soon after EMIC is characterised by "reflection". And, the period 10–12 months after the EMIC program is characterised by "application". These terms are used in the discussions of Alan's change in the different study periods.

The discussion of each of the study time periods is set out in three sections:

About this period—This section outlines information specific to the period, and presents lesson vignettes of the period.

Overview—In this section an overview of changes in Alan's Classroom Practice is presented. The Interconnected Model is used to represent these changes, and a description of the characteristic activity of the period is provided.

Descriptions of Alan's Classroom Practice—In this section changes in Alan’s practice, knowledge and beliefs with respect to Teaching Strategies, Resource Use and Assessment Strategies are described in detail. The Interconnected Model is used to represent changes in Alan’s Classroom Practice in the form of change sequences.

6.3.1 During the EMIC Program

About this period

During this period, Alan participated in the EMIC inservice sessions which were conducted fortnightly. The sessions were held after school hours at Alan’s school, and they were conducted by a trained program tutor, Tanya, who was a colleague of Alan.

Alan taught a composite Grade 4/5 class throughout the period. There were 24 students in Alan’s class.

Figure 6.3 presents an overview of the data collected during this period.
Interview 1, the first of three structured interviews conducted in this study, took place in this period. Much of the information obtained from Alan during Interview 1, was focused on his mathematics teaching prior to his involvement in EMIC. Therefore in the discussion of this period, there are fewer references to interview data than in the discussions of the other periods.

Two lessons were observed in Alan’s classroom during this period (Observations 1 and 2). Outlines of these lessons are presented in Vignettes 6.1 and 6.2. Alan’s use of activities and ideas associated with the EMIC program in these lessons can be noted.

**Vignettes 6.1 and 6.2**

**Vignettes of Lessons Observed During the EMIC Program: Alan**

<table>
<thead>
<tr>
<th>VIGNETTE 6.1</th>
<th>VIGNETTE 6.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: Observation 1, June, Grade 4/5)</td>
<td>(Source: Observation 2, August, Grade 4/5)</td>
</tr>
<tr>
<td>Alan presented a smorgasbord of problem solving activities (obtained from an EMIC session) to his class. The problem statements were located at various points around the room together with any materials and equipment required. The students worked in groups of three, selecting from the range of activities available. The groups worked at their own pace to solve the problems selected, and were required to record their solutions. Alan observed the students as they worked and he recorded what he considered were significant observations as anecdotal notes. Towards the end of the session Alan conducted a discussion with the whole class related to two of the problems. The discussion focused on processes and solutions.</td>
<td>This was the second session in a unit on fractions (a unit originally prepared by a colleague, Tanya, who also happened to be the EMIC tutor). Alan explained the tasks to all students, then allocated student pairs to work together. Each pair had fraction materials and equipment to work with (eg fraction kits, fraction cakes, cuisenaire), and they sat at various points around the room making use of available carpet space. At first the students freely explored the materials, then Alan asked them to examine size relationships of the materials. Alan moved around the room observing pairs at work and asking questions of them when he felt it was appropriate.</td>
</tr>
</tbody>
</table>
Overview: A focus on “exploration”

The period during the EMIC program can broadly be characterised as a time of “exploration” for Alan. Making use of the new ideas presented to him in EMIC, he engaged in classroom experimentation in each of the Classroom Practice components examined: Teaching Strategies; Resource Use; and Assessment Strategies. This experimentation is represented in the diagram by the arrows linking the External Domain with the Domain of Practice. Alan also began to reflect on his experimentation with respect to consequences—in particular, the outcomes of his experimentation for his students. This reflection is represented by the arrows linking the Domain of Practice with the Domain of Consequence. In addition, it appeared that Alan’s beliefs about mathematics teaching with respect to Teaching Strategies changed. These changed beliefs appeared to result from his reflection on the outcomes of his experimentation, as represented by the arrow linking the Domain of Consequence with the Personal Domain. It is important to stress that other changes may also have occurred at this time. The diagram above and the following discussion are restricted to only those changes for which explicit empirical data were obtained. This similarly applies to the discussions of the other periods presented later in this section.

Exploring Teaching Strategies and reflecting on the consequences

During Observations 1 and 2, Alan was observed experimenting with several teaching strategies that he learnt of at EMIC that were “new” to his mathematics teaching. As he made use of problem solving activities in Observation 1, and fraction activities in Observation 2, he explored different student groupings, discourse types and task types. Comments Alan made during this period, and in later periods, suggested that the particular strategies new to his mathematics teaching included: group and pair activities, discussions, practical tasks, and open ended tasks. Each of these teaching strategies was examined during EMIC sessions. Alan’s enactment of these ideas presented in EMIC is represented in the diagram by the arrow linking the External Domain with the Domain of Practice.
Table 6.1 displays a summary of the teaching strategies Alan used during Observations 1 and 2, and those he referred to during Interview 1.

Table 6.1
Alan’s Teaching Strategies: Observed and Reported During the EMIC Program

<table>
<thead>
<tr>
<th>STRATEGY</th>
<th>OBSERVATIONS 1 &amp; 2 DURING EMIC</th>
<th>INTERVIEW 1 DURING EMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUDENT GROUPING</td>
<td>• group (1)</td>
<td>• whole class</td>
</tr>
<tr>
<td></td>
<td>• pairs (2)</td>
<td></td>
</tr>
<tr>
<td>DISCOURSE</td>
<td>• discussion (1)</td>
<td>• explanation/demonstration</td>
</tr>
<tr>
<td></td>
<td>• explanation/demonstration (2)</td>
<td></td>
</tr>
<tr>
<td>TASK</td>
<td>• problem solving (1)</td>
<td>• problem solving</td>
</tr>
<tr>
<td></td>
<td>• practical task (2)</td>
<td>• games</td>
</tr>
<tr>
<td></td>
<td>• open ended task (2)</td>
<td></td>
</tr>
<tr>
<td>CONTEXT</td>
<td>• mathematics (1, 2)</td>
<td>• mathematics</td>
</tr>
<tr>
<td>TEACHERS</td>
<td>• class teacher only (1, 2)</td>
<td>• parent involvement</td>
</tr>
</tbody>
</table>

During Interview 1 Alan reported a limited awareness of different strategies for teaching mathematics. He spoke of few teaching strategies overall (see Table 6.1), and most of those he referred to reflected his traditional teaching orientation. When asked whether he was aware of any innovative techniques for teaching mathematics, he responded:

Not really, no, because I've been out of the classroom. And that's one of the reasons for me going to EMIC—to find out some of the things that are happening. (Alan, Interview 1, p. 4)

It seemed that Alan’s expressed desire to learn of new strategies through the EMIC program was soon realised. In an informal discussion during Observation 1, he initiated a conversation about his exploration of some teaching strategies he had been introduced to in EMIC. Alan said that he was attempting to explore all of the EMIC activities that he considered were appropriate for his students. He talked about different activities that he had recently explored, and he pointed out a number of related examples of student work that were displayed around his room (Alan, Fieldnotes, Observation 1).

As Alan experimented with different teaching strategies, he began to reflect on these new ways of teaching with respect to the consequences for his students. For example, during Observation 2, as his students worked on a number of open ended tasks related to fractions (see Vignette 6.2), he reported that his students were “really looking at the
sizes [of the pieces of equipment] and comparing them” (Alan, Fieldnotes, Observation 2). Alan appeared to value this as significant learning, and he attributed this learning to the particular teaching strategies he was exploring. He noted that one student who usually had difficulty staying “on task” when more rigid guidelines were set [as he inferred was the case with his previous mode of teaching], could actually “work on this activity all day” (Alan, Fieldnotes, Observation 2). Alan also spoke enthusiastically of “great things” that his students had been doing in a similar mathematics session held the day before Observation 2. These comments are represented in the diagram by the reflection arrow linking the Domain of Practice with the Domain of Consequence.

The positive salient outcomes that Alan identified as he reflected on his exploration of the teaching strategies introduced to him in the EMIC program, appeared to impact on his view of his mathematics teaching. His enthusiasm for the new strategies that he explored suggested a change in belief as to their efficacy. It appeared that Alan began to value these new strategies as worthy of inclusion in his mathematics teaching strategies repertoire. Alan’s reflection in this area is represented in the diagram by the arrow linking the Domain of Consequence with the Personal Domain.

**Exploring Resource Use**

During this period Alan explored some “new” resources and some new ways of using resources that he learnt about during EMIC sessions. Specifically, during Observations 1 and 2, he made use of commercial and school based publications, mathematics teaching and learning equipment and materials, and technology. Table 6.2 displays the resources Alan used during the lessons observed, and those he referred to during Interview 1.

During Observation 1 Alan made use of a series of problem solving tasks introduced as part of the EMIC program. As his students worked on the tasks they used miscellaneous general materials and mathematics teaching and learning equipment, as well as calculators. The importance of having these materials available for students to use for these problem solving tasks had been emphasised during an EMIC session, and Alan encouraged his students to use them. He also explicitly asked students about how the resources assisted them in completing the tasks during the discussion held at the end of the lesson.
### Table 6.2

**Alan's Resource Use: Observed and Reported During the EMIC Program**

<table>
<thead>
<tr>
<th>RESOURCE TYPE</th>
<th>OBSERVATIONS 1 &amp; 2 DURING EMIC</th>
<th>INTERVIEW 1 DURING EMIC</th>
</tr>
</thead>
</table>
| COMMERCIAL PUBLICATIONS | • problem solving tasks [published in EMIC] (1) | • miscellaneous courses  
| | | • Rigby  
| | | • Victorian Primary Maths Program |
| SCHOOL BASED PUBLICATIONS | • fraction unit (2) | |
| MATHEMATICS TEACHING AND LEARNING EQUIPMENT AND MATERIALS | • fraction kits (2)  
| | | • cuisenaire (2)  
| | | • miscellaneous materials (1)  
| TECHNOLOGY | • calculators (1) | • Unifix  
| | | • MAB |
| GENERAL MATERIALS (NON-MATHEMATICS TEACHING AND LEARNING SPECIFIC) | • miscellaneous materials (1) | • miscellaneous equipment/maths room |
| HUMAN RESOURCES | | • resource people (colleagues, tutor) |

In Observation 2, Alan used a unit of work produced by a colleague, Tanya (who also happened to be the EMIC tutor), and his students used fraction kits and cuisenaire. He stated that, during an EMIC session, Tanya had emphasised that it is important to provide opportunities for students to freely explore “new” materials prior to working on specific tasks. Alan incorporated this suggestion into his lesson.

While Alan made few comments with respect to his use of resources during the classroom lessons observed in this period, he made reflective comments in interviews later in the study that suggested these lessons were times of experimentation for him with respect to the use of resources. In particular, Alan reported that prior to his involvement in EMIC, his awareness of resources for teaching mathematics and his knowledge with respect to how to use resources effectively was limited. Specific comments made by Alan will be presented in the discussions of the later periods of the study. Alan’s enactment of the Resource Use strategies presented during EMIC is represented in the diagram by the arrow linking the External Domain with the Domain of Practice.
Exploring Assessment Strategies and reflecting on the consequences

During early observations conducted in Alan’s classroom, it was obvious that he was enthusiastic about exploring some of the alternative assessment strategies introduced in EMIC. Table 6.3 displays the assessment strategies he used during lessons observed and those strategies he referred to during Interview 1.

Table 6.3
Alan’s Assessment Strategies: Observed and Reported During the EMIC Program

<table>
<thead>
<tr>
<th>ASSESSMENT STRATEGY</th>
<th>OBSERVATIONS 1 &amp; 2 DURING EMIC</th>
<th>INTERVIEW 1 DURING EMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEASUREMENT STRATEGY</td>
<td>• observation (1, 2)</td>
<td>• student self assessment</td>
</tr>
<tr>
<td></td>
<td>• interview/questioning (1, 2)</td>
<td>• test</td>
</tr>
<tr>
<td>RECORDING STRATEGY</td>
<td>• anecdotal record (1)</td>
<td>• checklist</td>
</tr>
</tbody>
</table>

During Observations 1 and 2 Alan observed students and questioned them as they worked on their mathematics tasks. During Observation 1 he recorded his observations of groups of students as anecdotal notes. He noted particular strategies they were using, as well as information related to their interests and work practices (for example who they worked with and participation levels). During Interview 1 Alan spoke of only two assessment strategies that he had previously used—tests and checklists. He also mentioned one strategy that he had heard about but had not tried—student self-assessment. The assessment strategies Alan was exploring in Observations 1 and 2 were obviously new to his mathematics teaching. Alan’s enactment of the new assessment strategies presented at EMIC is represented in the diagram by the arrow linking the External Domain with the Domain of Practice.

In an informal discussion during Observation 2, Alan reported that his observations of students as they worked provided an invaluable source of information for assessing their performance, and for informing his teaching. He noted, for example, one student’s keen interest in, and uncharacteristic application to, the task he was working on (Alan, Fieldnotes, Observation 2). Alan stated that he had previously thought that the student was experiencing difficulties with much of the content that was being presented. However, after observing him at length, Alan said that he realised that the
student was in fact quite capable. Alan attributed the student's interest in the lesson to the teaching strategies he was using—in particular, the open ended and practical design of the tasks. He stated that he felt this way of working appeared to "suit" this student well. Alan noted that he would use this information in the planning of future lessons. In the diagram the arrow linking the Domain of Practice with the Domain of Consequence represents Alan's reflection on his exploration of observation as an assessment strategy.

6.3.2 Soon After the EMIC Program

About this period

The period soon after the EMIC program spanned the time from when the EMIC program finished to 8 months following the completion of the program. During this period, as one school year finished and another commenced, Alan changed classes and teaching levels. At the beginning of the period Alan was teaching a composite Grade 4/5 class of 24 students. Later, he worked with a Grade 3 class of 28 students. These changes in class and level need to be taken into account when considering the data collected in this period. For example, it might be that a stimulus for Alan's exploration of different teaching strategies during the later part of this period was his new class and students.

Figure 6.4 presents an overview of the data collected soon after the EMIC program. During this period, the second structured interview (Interview 2), was conducted, and Alan completed a written questionnaire. Four lessons were also observed in Alan's classroom (Observations 3-6). Outlines of these lessons are presented in Vignettes 6.3, 6.4, 6.5 and 6.6.

\[\text{SEPT} | \text{OCT} | \text{NOV} | \text{DEC} | \text{JAN} | \text{FEB} | \text{MAR} | \text{APR}\]

\[\text{INT 2} | \text{OBS 3} | \text{QST} | \text{OBS 4} | \text{SCHOOL SUMMER VACATION} | \text{OBS 5} | \text{OBS 6}\]

\text{INT} = \text{Interview}; \text{OBS} = \text{Observation}; \text{QST} = \text{Questionnaire}

\text{Figure 6.4. Overview of data collected: Soon After the EMIC Program.}
It should be noted that the lesson described in Vignette 6.4 was observed on December 11, which was very close to the end of the school year. During an informal conversation with Alan on that date, he suggested that he was in “wind down mode” for the year (Alan, Fieldnotes, Observation 4). He explained that this meant he was involving his students in revision and skills consolidation activities, rather than working on any new content or topics.

Vignettes 6.3, 6.4, 6.5 and 6.6

Vignettes of Lessons Observed Soon After the EMIC Program: Alan

<table>
<thead>
<tr>
<th>VIGNETTE 6.3</th>
<th>VIGNETTE 6.4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Source: Observation 3, October, Grade 4/5)</strong></td>
<td><strong>(Source: Observation 4, December, Grade 4/5)</strong></td>
</tr>
<tr>
<td>Alan directed the students to complete a photocopied worksheet related to shape and size. The task required the students to reproduce a drawing of a robot at double the size. The students worked independently in rows of desks using rulers and graph paper to complete the worksheet task. Alan moved around the room talking with some students. Throughout the lesson two students worked with drill and practice programs on the class computer. There was no structured closure to the lesson.</td>
<td>As in Observation 3, Alan explained a routine worksheet task to his students which they then completed independently at their desks. The worksheet comprised calculations involving each of the four operations, (the calculations were set inside Christmas illustrations which the students had to colour a particular way according to the solutions). Alan moved around the desks asking some students questions related to processes and solutions. Students who completed the worksheet prior to the end of the session could play maths games.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VIGNETTE 6.5</th>
<th>VIGNETTE 6.6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Source: Observation 5, March, Grade 3)</strong></td>
<td><strong>(Source: Observation 6, April, Grade 3)</strong></td>
</tr>
<tr>
<td>Alan introduced his students to MAB materials via a discussion about the different pieces. He asked his students what they knew about them, then explained their values. He described two games (Win-a-flat, Lose-a-flat), and students organised themselves into groups of four or five in the floor space around the room and played the games. Alan moved around observing the students as they worked and asked questions of them when he felt it was appropriate. Toward the end of the lesson Alan led a discussion about the games. The discussion focused on strategies, difficulties with trading, and dice combinations. He posed a question related to dice combinations and suggested that they would work further on it during the next session.</td>
<td>Alan placed the students into pairs and directed them to use MAB materials to complete a worksheet of addition and subtraction calculations (some involving trading). The students worked together on the floor manipulating the materials and recording their solutions. Alan observed them at work and recorded anecdotal notes. Part way through the session Alan stopped the students and discussed with them particular questions on the worksheet. The students then continued to work on the tasks. There was no structured closure to the lesson.</td>
</tr>
</tbody>
</table>
Overview: A focus on "reflection"

The period following the EMIC program saw Alan demonstrate and report many changes with respect to his Classroom Practice. He continued to explore new areas related to each Classroom Practice component, while his increased activity with respect to reflection was of particular note. Alan reflected on his classroom explorations with respect to consequences (represented by the arrows linking the Domain of Practice with the Domain of Consequence, and the Domain of Consequence with the Personal Domain), and with respect to the nature of his changed practice (represented by the arrows linking the Domain of Practice with the Personal Domain). Alan’s reflection led to some changes in his beliefs about mathematics teaching and learning. As a consequence of these changed beliefs Alan sought further input from external sources (represented by the enactment arrows linking the Personal Domain with the External Domain).

Reflecting on Teaching Strategies and seeking further ideas about integrating them

Comments made by Alan during Interview 2 indicated that he felt his teaching was changing considerably. Alan reflected on his classroom experimentation with respect to the nature of his mathematics teaching practice, and with respect to the consequences of his changed practice. He further reported changes in his beliefs about mathematics teaching and learning.

Alan reported particular changes with respect to his use of teaching strategies. For example, he made reference to the fact that he was encouraging more student discussion and active involvement during mathematics lessons. He stated that there was less emphasis on him “telling” students what to do and consequently more emphasis on them actually “doing” mathematics.

Have the children doing, and learning through their doing. Not me telling them that this is what they’re supposed to be doing. ... I give
them the opportunity to explore now, and also there is a lot more group work rather than just individual work. And it means they have the chance to discuss with one another and learn from one another. (Alan, Interview 2, p. 2)

He also made comments in Interview 2 about general changes to his mathematics teaching.

My teaching methods have changed with regards to teaching maths. I was pretty much chalk and talk before and ... yeh, the whole approach towards teaching maths [is different]. (Alan, Interview 2, p. 1)

During some of the classroom lessons observed in this period, Alan made further reflective comments related to the nature of his teaching. These comments appeared to indicate that while Alan may have been committed to changing his teaching practice, the ideas he was exploring had not yet become part of his ongoing practice. For example, in an informal discussion during Observation 4 (see Vignette 6.4), he pointed out that his teaching style “alters with [his] personal moods or situation” (Alan, Fieldnotes, Observation 4). He suggested that sometimes when he is tired or stressed he operates in “survival mode” resorting to routine worksheets or work on the board, and at other times when he has time to commit and is feeling enthused, he enjoys experimenting with strategies and activities from EMIC (Alan, Fieldnotes, Observation 4). The lessons observed early in this period illustrated Alan’s “survival mode” teaching. During Observations 3 and 4, Alan simply explained to his students the procedure for completing set tasks outlined on routine worksheets, and they worked independently to complete them. These examples highlight the perceived difficulties associated with changing one’s teaching practice. Alan’s reflection on the changing nature of his teaching is represented in the diagram by the arrow linking the Domain of Practice with the Personal Domain.

During observations conducted later in the period, Alan continued to explore strategies introduced to him by EMIC. Observations 5 and 6 were conducted when Alan was working with a new class of Grade 3 students at the beginning of the school year (see Vignettes 6.5 and 6.6). During these lessons he involved students in discussions about their mathematics learning, he used different student groupings, and he made use of mathematics games. In the diagram presented in this section, the arrow linking the External Domain with the Domain of Practice represents Alan’s exploration of these new teaching strategies.

Table 6.4 displays the teaching strategies Alan used in lessons observed in this period, and the strategies he referred to in Interview 2.
Table 6.4
Alan’s Teaching Strategies: Observed and Reported Soon After the EMIC Program

<table>
<thead>
<tr>
<th>STRATEGY</th>
<th>OBSERVATIONS 3, 4, 5 &amp; 6 SOON AFTER EMIC</th>
<th>INTERVIEW 2 SOON AFTER EMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUDENT GROUPING</td>
<td>• individual (3, 4)</td>
<td>• group</td>
</tr>
<tr>
<td></td>
<td>• group (5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• pairs (6)</td>
<td></td>
</tr>
<tr>
<td>DISCOURSE</td>
<td>• discussion (4, 5, 6)</td>
<td>• discussion</td>
</tr>
<tr>
<td></td>
<td>• explanation/demonstration (3, 4, 5)</td>
<td></td>
</tr>
<tr>
<td>TASK</td>
<td>• routine worksheet (3, 4, 6)</td>
<td>• physical activity</td>
</tr>
<tr>
<td></td>
<td>• games (4, 5)</td>
<td></td>
</tr>
<tr>
<td>CONTEXT</td>
<td>• mathematics (4, 5, 6)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• theme work (3)</td>
<td></td>
</tr>
<tr>
<td>TEACHERS</td>
<td>• class teacher only (3, 4, 5, 6)</td>
<td></td>
</tr>
</tbody>
</table>

During Interview 2 Alan spoke positively of the impact of his classroom experimentation on his students.

They’re more interested in participating in the sessions. ... It’s not a chore, it’s fun. ... And it’s being successful, the kids are really picking it up. They understand what they’re doing and they’ve enjoyed it. (Alan, Interview 2, p. 2)

He spoke specifically of one student whom he felt benefited greatly from the different teaching strategies he was using. Alan described the student’s increased level of interest, involvement, and achievement, in response to the open ended tasks he had been exploring.

One child in here ... he has been absolutely sensational since I’ve had them working in this way. He’s just totally involved, works brilliantly. ... He was receiving extra assistance at school for the past x years and I look at him working now and I wonder why. It really suits him—I mean that’s how good it can be. (Alan, Interview 2, p. 4)

Alan also spoke of his increased satisfaction with his mathematics teaching. He stated that he liked to watch his students enjoying mathematics lessons, and he reported his increased enjoyment of teaching as a personal outcome of his classroom experimentation.

I’m much happier, much happier. (Alan, Interview 2, p. 2)

I’m enjoying it more and so are the kids. (Alan, Interview 2, p. 5)
Alan's reflection with respect to the consequences of his changed practice is represented in the diagram by the arrow linking the Domain of Practice with the Domain of Consequence. His reflection on the salient outcomes associated with his changed practice (for example, the outcomes for students referred to above), is represented by the arrow linking the Domain of Consequence with the Personal Domain.

During this period Alan began to articulate a desire to move beyond experimenting with teaching strategies in one-off activities or lessons, to incorporating them into his ongoing classroom practice. In response to a question included on the questionnaire given to participants during this period he wrote:

At EMIC we did lots of great activities which I have used in the classroom. However they were used as isolated activities. I'd like assistance in tying up, or adopting an EMIC approach to the total maths program. (Alan, Questionnaire, p. 1)

A comment made by Alan during Interview 2 further emphasised his need for additional external input.

I just thought all right, there are these fantastic activities and I really like them, now I want to know how to tie them in to my existing program. ... Just planning, course planning I suppose. (Alan, Interview 2, p. 5)

These responses suggest a change in the Personal Domain. It appeared that Alan had come to value the teaching strategies he had been using to the extent of seeking assistance with their inclusion as a regular feature of his teaching. Alan's enactment of these ideas is represented in the diagram in the arrow linking the Personal Domain with the External Domain.

Reflecting on Resource Use

Alan's comments with respect to resource use during Interview 2 were focused on the nature of his practice. In particular he reported an increase in the number of resources he was using, and a change in the way in which he accessed and selected resources.

The kids are using more concrete materials in maths now as a result of me doing that [EMIC]. Things like fraction kits and cuisenaire, and just anything that's going to be of benefit for what we're doing, rather than having everything in the abstract. I'm still using
anything I can find, I mean, but my starting point is different. Before I was the type of person that if I had a maths course or a couple of maths books, I'd tend to start at page one and work through. Now if I'm doing like that fractions unit, I'm more likely to go in search of maths books and text books and look through to see is there anything in these books that's relevant to what I'm doing? So now I'm looking for anything I can find that might be of help to what I'm actually doing. So I'm working in the opposite direction I think, coming from a different place. (Alan, Interview 2, p. 3)

As he made this comment, Alan's enthusiasm for his changed practice with respect to resource use was evident. He considered that he had become aware of how to use and access resources more effectively. Alan's reflection on the nature of his practice with respect to resource use is represented in the diagram by the arrow linking the Domain of Practice with the Personal Domain. His changed practice with respect to seeking more resource ideas is represented by the enaction arrow linking the Personal Domain with the External Domain.

There was no evidence of experimentation with resources in the observations conducted in Alan's classroom early in this period (Observations 3 and 4). This is not surprising given the nature of these lessons (see Vignettes 6.3 and 6.4). However, during the lessons observed later in the period there was some evidence of experimentation with respect to the way in which Alan used resources. In particular, the approach he adopted for introducing and discussing the use of MAB materials during the classroom lessons observed with his Grade 3 class (see Vignettes 6.5 and 6.6), appeared to be consistent with approaches emphasised in the EMIC program.

For example, Alan first tried to establish, and make use of, his students' knowledge of the materials. He then encouraged them to explore the materials, and later he discussed with them ways in which the use of the materials assisted their learning. It appeared that Alan was continuing to explore the strategies he learnt about at EMIC. His enaction of these EMIC ideas is represented in the diagram by the arrow linking the External Domain with the Domain of Practice.

Table 6.5 displays the resources Alan used in lessons observed, and the resources he referred to in Interview 2.
Table 6.5
Alan’s Resource Use: Observed and Reported Soon After the EMIC Program

<table>
<thead>
<tr>
<th>RESOURCE TYPE</th>
<th>OBSERVATIONS 3, 4, 5 &amp; 6 SOON AFTER EMIC</th>
<th>INTERVIEW 2 SOON AFTER EMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMERCIAL PUBLICATIONS</td>
<td>• worksheet (3)</td>
<td>• miscellaneous maths books, text books</td>
</tr>
<tr>
<td>SCHOOL BASED PUBLICATIONS</td>
<td>• worksheet (4, 6)</td>
<td>• fraction unit</td>
</tr>
<tr>
<td>MATHEMATICS TEACHING AND LEARNING EQUIPMENT AND MATERIALS</td>
<td>• graph paper (3) • rulers (3) • MAB (5, 6) • dice (5)</td>
<td>• fraction kits • cuisenaire</td>
</tr>
<tr>
<td>TECHNOLOGY</td>
<td>• computer software (3)</td>
<td></td>
</tr>
<tr>
<td>GENERAL MATERIALS (NON-MATHEMATICS TEACHING AND LEARNING SPECIFIC)</td>
<td></td>
<td>• miscellaneous equipment/maths room</td>
</tr>
<tr>
<td>HUMAN RESOURCES</td>
<td></td>
<td>• resource person (tutor)</td>
</tr>
</tbody>
</table>

While Alan attributed his new knowledge and awareness of resources directly to his participation in the EMIC program, he also acknowledged the assistance provided to him by his colleague, the EMIC tutor, Tanya. He saw Tanya herself as a valued resource.

My biggest resource is having Tanya in the school.
(Alan, Interview 2, p. 3)

Reflecting on Assessment Strategies

- Comments Alan made in Interview 2 provided evidence that he reflected on the nature of his assessment practice. He spoke of his new knowledge of effective assessment strategies including observation and the keeping of anecdotal records.

Now I look at their work as well. I don’t use columns with what they got out of twenty. I'm more likely to be writing notes about … what I observe. That was one of the things that I learnt from EMIC, and I immediately came up and did it, you know got out the grade list and watched them, and just made comments. Not necessarily
about every child, but I noticed that some things really stood out
that needed putting down. (Alan, Interview 2, p. 4)

Alan’s reflection on the nature of his assessment practice is represented in the diagram
by the arrow linking the Domain of Practice with the Personal Domain.

Alan also made comments that indicated his growing awareness of the usefulness of
the assessment strategies he was exploring. He reported that he felt as though
strategies including observation and questioning, and the keeping of anecdotal records,
enabled him to gather better quality information than he had previously been able to
collect.

I’m assessing them in a different way now. Rather than correcting
books and seeing if they’ve got everything correct, or finding out
what I thought they didn’t know and then trying to help them that
way, I can get a better overall view now from watching them, from
listening to them, from questioning them about what they’re doing.
I actually learn more about the children as people from what
they’re doing and watching them now. (Alan, Interview 2, p. 4)

In the diagram, the arrow linking the Domain of Practice with the Domain of
Consequence, and the arrow linking the Domain of Consequence with the Personal
Domain represent this reflection.

In addition to reflecting on his practice, Alan continued to explore some assessment
strategies through the period soon after the completion of the program. During
Observation 3, as previously discussed, Alan appeared to be working in what he later
referred to as “survival mode”, with students working independently on a routine
worksheet. However, he continued to make observations of students as they worked
and he questioned students and discussed strategies they were using. While during
Observation 4 there was no evidence of any assessment strategies being used, during
Observations 5 and 6 he used assessment strategies including observation and
questioning of students, and he recorded significant events in the form of anecdotal
records. This exploration is represented in the diagram by the enaction arrow linking
the External Domain with the Domain of Practice.

Table 6.6 displays the assessment strategies Alan used during each of the lessons
observed in this period and the strategies he referred to in Interview 2.
Table 6.6
Alan's Assessment Strategies: Observed and Reported Soon After the EMIC Program

<table>
<thead>
<tr>
<th>ASSESSMENT STRATEGY</th>
<th>OBSERVATIONS 3, 4, 5 &amp; 6 SOON AFTER EMIC</th>
<th>INTERVIEW 2 SOON AFTER EMIC</th>
</tr>
</thead>
</table>
| MEASUREMENT STRATEGY | • observation (3, 5, 6)  
                      | • interview/questioning (3, 5)  
                      | • work sample (3)            | • observation  
                      | • interview/questioning  
                      | • work sample            |
| RECORDING STRATEGY  | • anecdotal record (6)                | • anecdotal record          |

6.3.3 Ten to Twelve Months After the EMIC Program

About this period

Throughout this period Alan continued to teach the Grade 3 class he had been working with in the previous study period.

Figure 6.5 provides an overview of the data collected 10–12 months after the EMIC program.

```
MAY    JUNE    JULY
OBS 7   INT 3
```

\[ INT = \text{Interview}; \ OBS = \text{Observation}\]

\textit{Figure 6.5.} Overview of data collected: 10–12 Months After the EMIC Program.

The third structured interview (Interview 3) was conducted in this period, and one lesson was observed in Alan’s classroom (Observation 7). Although it was initially proposed that two observations be conducted, Alan was on leave (Long Service Leave) from his school for most of the period, and it was not possible to organise a second observation. An outline of the lesson observed in Alan’s classroom is presented in Vignette 6.7.
Vignette 6.7
Vignette of Lesson Observed 10–12 Months After the EMIC Program: Alan

**VIGNETTE 6.7**
(Source: Observation 7, July, Grade 3)

This lesson began with a whole class game (What's My Number?) involving all of the students physically. Following the game, Alan led a discussion about money and equivalent amounts, demonstrating with plastic money pieces. The students then used the plastic money to explore different equivalent amounts, and they recorded their findings. Together the class discussed the possible combinations that could be made to achieve certain amounts. The students then independently explored further amounts and another class discussion related to possible combinations concluded the session.

**Overview: A focus on "application"**

The period 10–12 months after the EMIC program is characterised by the "application" of Alan's new knowledge and beliefs into his ongoing classroom practice. During this period Alan continued to engage in experimentation and reflection, and he consolidated his changed practice. The "application" of Alan's learning to his ongoing mathematics teaching practice appears a logical progression from the previous periods of "exploration" and "reflection".

**Applying Teaching Strategies**

During Interview 3 Alan reported significant changes in his use of teaching strategies and he attributed those changes to EMIC. He described his application of an increased variety of teaching strategies to his ongoing teaching practice, and he referred more generally to changes in his total approach to teaching the subject.
Well, when I first spoke to you about this I was always extremely formal, my maths teaching was always really formal. Obviously I've learnt that there are better ways and more interesting ways to teach maths. (Alan, Interview 3, p. 2)

It's just that I'm always looking for practical means, far more than I used to, and interesting approaches to use that the children will enjoy and benefit from. So it's not all teacher directed. There's more self discovery and sharing. (Alan, Interview 3, p. 2)

I use groups and pairs and things like that rather than just this is how you do it, putting 30 problems up on the board and saying open your books and go for it. So a lot of it's different ... Just a whole lot of things to make maths more interesting. (Alan, Interview 3, p. 2)

During the lesson observed in this period there was some evidence of Alan's application of the teaching strategies he had learnt about at EMIC. During Observation 7 Alan used several of the strategies he had begun to explore in earlier periods (see Vignette 6.7). In addition, he tried for the first time involving his students in a new task type—a physical activity. During an informal discussion, Alan stated that he had wanted to explore that strategy since he had learnt about it at EMIC, but had not had an appropriate opportunity to do so (Alan, Fieldnotes, Observation 7). Alan's experimentation with this new task type is represented in the diagram by the enaction arrow linking the External Domain with the Domain of Practice. His reflection with respect to his use of teaching strategies is represented by the reflection arrow linking the Domain of Practice with the Personal Domain. And, his application of the teaching strategies learnt about at EMIC is represented by the enaction arrow linking the Personal Domain with the Domain of Practice.

Table 6.7 displays the strategies Alan used during the lesson observed, and the specific strategies he referred to during Interview 3.
Table 6.7  
Alan’s Teaching Strategies: Observed and Reported 10–12 Months After the EMIC Program

<table>
<thead>
<tr>
<th>STRATEGY</th>
<th>OBSERVATION 7 10-12 MONTHS AFTER EMIC</th>
<th>INTERVIEW 3 10-12 MONTHS AFTER EMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUDENT GROUPING</td>
<td>* individual</td>
<td>* group</td>
</tr>
<tr>
<td>DISCOURSE</td>
<td>* discussion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* explanation/demonstration</td>
<td></td>
</tr>
<tr>
<td>TASK</td>
<td>* games</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* oral task</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* physical activity</td>
<td></td>
</tr>
<tr>
<td>CONTEXT</td>
<td>* mathematics</td>
<td></td>
</tr>
<tr>
<td>TEACHERS</td>
<td>* class teacher only</td>
<td></td>
</tr>
</tbody>
</table>

Applying Resource Use

During the period 10–12 months after the EMIC program, Alan reported a number of changes to his mathematics teaching that indicated he was applying new knowledge and beliefs with respect to resource use. During Interview 3, he spoke of three specific changes, and he attributed these changes to his participation in EMIC. First, Alan reported that he used more resources than he did prior to participating in EMIC.

Well I use more resources than I used before [doing EMIC]. I’m up in the maths room quite frequently finding things to use. I use any type of equipment that goes with whatever I’m doing at the time. The children use them hands-on. (Alan, Interview 3, p. 4)

While this comment could appear to indicate a somewhat indiscriminate selection of resources, this certainly was not Alan’s intention, and it did not appear to be the case in practice. It was more an expression of Alan’s enthusiasm with respect to the new ways he was working with resources. The following interview excerpt provides a further example of this.

We get anything that we can. For example we decided that we needed to do some more calculator work, so we went and got every calculator book that we could find was in the school. ... And we chose activities out of the books that we could use, that were suitable for our children, our level. (Alan, Interview 3, p. 4)
The second change reported by Alan with respect to resource use concerned the planning of his mathematics program. He considered that he approached the planning of his mathematics lessons differently through consulting a wider range of references. During an informal discussion following the classroom lesson observed in this period, Alan reported that he felt the planning of his mathematics program had improved since being involved in EMIC. He mentioned a variety of references that he regularly consulted, and he stated that he felt more confident in accessing teaching activities and ideas. Alan’s reflection on the nature of his resource use is represented in the diagram by the reflection arrow linking the Domain of Practice with the Personal Domain. His application of his new knowledge and beliefs with respect to resource use is represented by the enactment arrow linking the Personal Domain with the Domain of Practice.

Alan reported a further change with respect to resource use. He stated that he had come to appreciate, and make more effective use of, the “people support” (human resources) available to him (Alan, Fieldnotes, Observation 7). In particular he referred to the support of his colleagues, and more specifically Tanya, the EMIC tutor. He said that he actively sought teaching ideas and activities from Tanya and other members of staff at School A.

Well, Eva and I, that’s who I’m working with, we do all our planning together now. ... We go through each particular unit of work that we’re going to do. ... We discuss it, and also use Tanya as well. ... We come up with different ideas that we can use.
(Alan, Interview 3, p. 1)

I’ve got a resource person [Tanya] here that I can go to anytime I need to. ... It’s great. ... There’s a lot of sharing here.
(Alan, Interview 3, p. 3)

We’re lucky with Tanya, because we’ve got so much to draw from.
(Alan, Interview 3, p. 4)

In the diagram, Alan’s seeking of ideas from others is represented in the enactment arrow linking the Personal Domain with the External Domain.

Table 6.8 displays the resources referred to by Alan during this interview and those resources he used during the lesson observed in this period.
Table 6.8
Alan's Resource Use: Observed and Reported 10–12 Months After the EMIC Program

<table>
<thead>
<tr>
<th>RESOURCE TYPE</th>
<th>OBSERVATION 7 10-12 MONTHS AFTER EMIC</th>
<th>INTERVIEW 3 10-12 MONTHS AFTER EMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMERCIAL PUBLICATIONS</td>
<td></td>
<td>• activity books</td>
</tr>
<tr>
<td>SCHOOL BASED PUBLICATIONS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHEMATICS TEACHING AND LEARNING EQUIPMENT AND MATERIALS</td>
<td>• plastic money</td>
<td>• miscellaneous equipment</td>
</tr>
<tr>
<td>TECHNOLOGY</td>
<td></td>
<td>• calculators</td>
</tr>
<tr>
<td>GENERAL MATERIALS (NON-MATHEMATICS TEACHING AND LEARNING SPECIFIC)</td>
<td>• stickers [numbered]</td>
<td>• miscellaneous equipment/maths room</td>
</tr>
<tr>
<td>HUMAN RESOURCES</td>
<td></td>
<td>• resource person (tutor)</td>
</tr>
</tbody>
</table>

Applying Assessment Strategies

During Observation 7 Alan appeared to be consolidating his use of the assessment strategies he had explored during earlier time periods. These included: observation, questioning and anecdotal records. During Interview 3, he reported changes in his assessment practices, and a changed attitude towards assessing students in mathematics.

I use observation a lot more than I used to, but then, well not really more than I used to, it's different than what it used to be. Rather than just going around and looking in their books, it's watching them in action with what they're doing. And also verbally a lot, talking to them. (Alan, Interview 3, p. 5)

I always thought that the way to assess children's performance in mathematics was to give them a test and whatever they got, like if it was worth 20 and they got 19 they had done really well, and if they got 10 they had done rotten, which is a very old style too. Now I've realised that important things are observation, and there are so many more things to evaluation [assessment] than just a score on a test. So when my kids are working in pairs or groups I spend as much time watching the children, the way they interact with one another and I tend to have a list and make comments about things that they
and I tend to have a list and make comments about things that they do and stuff just for a personal record. I think that’s as important as anything else that they can do. (Alan, Interview 3, p. 4)

Alan’s reflection on his experimentation with respect to the nature of his changed assessment strategies practice is represented in the diagram by the arrow linking the Domain of Practice with the Personal Domain. His application of the assessment strategies to his ongoing practice is represented by the enaction arrow linking the Personal Domain with the Domain of Practice.

Table 6.9 displays the assessment strategies Alan used in the lesson observed in this period, and the strategies he referred to during Interview 3.

Table 6.9
Alan’s Assessment Strategies: Observed and Reported 10–12 Months After the EMIC Program

<table>
<thead>
<tr>
<th>ASSESSMENT STRATEGY</th>
<th>OBSERVATION 7</th>
<th>INTERVIEW 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10–12 MONTHS AFTER EMIC</td>
<td>10–12 MONTHS AFTER EMIC</td>
</tr>
</tbody>
</table>
| MEASUREMENT STRATEGY | • observation  
• interview/questioning | • observation  
• interview/questioning  
• test |
| RECORDING STRATEGY   | • anecdotal record | • anecdotal record  
• checklist |

6.4 Alan’s professional growth

This section describes key aspects of Alan’s professional growth with respect to each component of Classroom Practice, and the growth networks that appeared to be associated with that growth.

6.4.1 Growth with respect to Teaching Strategies

Over the time of the study Alan was observed experimenting with a variety of strategies which were new to him, and he reflected on his experimentation during interviews and informal discussions. He reported that he incorporated several new strategies into his teaching strategies repertoire, and that he considered his professional growth in this area to be significant.
Alan reflected both on the nature and consequences of exploring new teaching strategies introduced to him in EMIC. His comments suggested that his use of different teaching strategies led him to value certain student learning outcomes—in particular, understanding of mathematical ideas, and enjoyment in mathematics lessons. Alan also stated that as he explored new strategies he was experiencing more enjoyment in his mathematics teaching.

Alan applied some of his new knowledge and beliefs to his ongoing practice. He also sought further external input related to teaching strategies. He articulated a desire to obtain more information about, and assistance with, incorporating new teaching strategies into his program planning.

In summary, key aspects of Alan’s growth with respect to Teaching Strategies included:

- knowledge of new strategies for teaching mathematics;
- an extended repertoire of teaching strategies; and
- new beliefs related to the efficacy of teaching strategies explored.

The growth network associated with Alan’s growth with respect to Teaching Strategies is displayed in Figure 6.6.

![Figure 6.6](image)

**Figure 6.6.** Alan’s growth network with respect to Teaching Strategies.

### 6.4.2 Growth with respect to Resource Use

Across the time of the study, during classroom observations and in interview responses, there was evidence of Alan’s experimentation with new resources, as well as changes to the ways that he made use of resources. Alan considered that he used more resources and that he used them more effectively. He spoke enthusiastically of
his new knowledge and awareness of resources. However he made no reference to the likely consequences of his changed practice in this area. It appeared that the nature of the changes related to Alan’s resource use were less outcomes oriented and more associated with the practicalities of him using the resources.

Although some of the changes reported by Alan in relation to his use of resources were not directly observed, the growth he reported in this area can be seen to be consistent across the time periods of the study, and in harmony with changes he demonstrated and reported in regards to his use of teaching strategies discussed earlier.

Key aspects of Alan’s growth with respect to Resource Use included:
- knowledge of new resources for teaching mathematics;
- knowledge of new ways of using familiar resources for teaching mathematics; and
- an increased use of resources for planning and teaching mathematics.

The growth network associated with Alan’s growth with respect to Resource Use is displayed in Figure 6.7.

![Figure 6.7](ext.png)

*Figure 6.7.* Alan’s growth network with respect to Resource Use.

### 6.4.3 Growth with respect to Assessment Strategies

Throughout the time of the study, changes in both Alan’s assessment practice and his attitude towards assessment were demonstrated in lessons observed, and reported in interviews. Alan reported an increased awareness and use of alternative assessment strategies in mathematics, both in structured interviews and informal discussions, and these reports were substantiated in observations made in his classroom over the time of the study. In particular he included observation, questioning of students, and anecdotal records as a regular part of his assessment practice. Alan also reported
changes in his beliefs about assessing student performance in mathematics. He stated that he came to value an assessment approach that utilised a number of alternative assessment strategies, as he felt that such an approach enabled the collection of better quality information.

The changes to Alan’s practice in this area that appeared to be enduring and therefore representing growth, included:
- knowledge of new strategies for assessing student learning in mathematics;
- an extended repertoire of assessment strategies; and
- new beliefs related to the efficacy of assessment strategies explored.

The growth network associated with Alan’s growth with respect to Assessment Strategies is presented in Figure 6.8.

![Figure 6.8. Alan’s growth network with respect to Assessment Strategies.](image)

### 6.4.4 Overall growth network associated with Classroom Practice

The black arrows displayed in this diagram represent the overall growth network associated with Alan’s growth with respect to Classroom Practice.

While no specific data provided evidence of growth networks involving the mediating processes represented by the green arrows in this diagram, it should not be concluded that these networks were not associated with Alan’s growth. For example, it may
be that Alan's reflection with respect to the consequences of his classroom experimentation in fact led him to experiment further in his classroom. If this were true, then the change sequence represented by the enactment arrow linking the Domain of Consequence with the Domain of Practice (shown in green in the diagram) would be applicable to him in this case. However, none of the data collected clearly revealed the occurrence of that change sequence, or the other change sequences represented in green, and therefore no growth networks involving these change sequences were identified.

What can be stated from an examination of Alan's growth networks is that for Alan, the process of professional growth stimulated by EMIC occurred primarily through reflection on classroom experimentation. Guskey's (1986) linear model of teacher change matches one aspect of Alan's growth:

Use of the Interconnected Model has enabled the identification of not only this change sequence but also the other change sequences that go to make up Alan's overall professional growth network.

6.4.5 Other aspects of growth

In addition to those areas of growth specifically associated with the three components of Classroom Practice described above, Alan also demonstrated and reported growth with respect to certain general aspects of his mathematics teaching. These included:

- his beliefs related to what mathematics teaching and learning involves;
- his confidence with respect to teaching mathematics; and
- his attitude towards his mathematics teaching.

A discussion of each of these is presented below. It should be noted that some interview excerpts cited in earlier sections are re-presented in these discussions to emphasise particular points.

Beliefs about mathematics teaching and learning

It appeared that through participating in EMIC, Alan not only learnt new strategies for teaching mathematics, but also changed some of his beliefs about the teaching and
learning of mathematics. Through his classroom experimentation and his reflection on the outcomes of that experimentation, he began to question his own experiences with teaching and learning mathematics.

I don’t think it’s good for the teacher to always be the focal point, and I think that that’s what I was. I don’t think that’s always the best way for children to learn, in fact [now] I know it’s not. So that was probably the last area that I came around in. It’s a lot easier with language, much easier. But when you’ve sort of got things in mind that they’re supposed to learn, and my memories are just so strong about how I learnt. I can remember my grade 5 and 6 teachers and the way that they taught me how to do fractions and long division and all that kind of thing. I learnt it the first time they told me and that’s how I always thought things were supposed to be taught. (Alan, Interview 3, p. 3)

Alan reported that the general teaching approaches presented in EMIC sessions encouraged him to reconsider what mathematics teaching and learning involved.

It really opened my eyes. It just made me realise that maths [teaching and learning] is really very different to what I thought it was, to what I always imagined it to be. It was the approach through EMIC. (Alan, Interview 2, p. 1)

Alan’s comments indicated a strong commitment to his new knowledge with respect to mathematics teaching and learning.

I’ve learnt [from EMIC] that there are better ways and more interesting ways to teach maths [than I was previously aware of]. (Alan, Interview 3, p. 2)

**Confidence with respect to teaching mathematics**

Across the time of the study Alan conveyed the impression that he was developing confidence with respect to his mathematics teaching. During the lessons observed in his classroom he appeared progressively more relaxed about, and certain of, the approaches he was using to teach mathematics. And, during informal discussions, he reported that he felt more comfortable about teaching mathematics. Alan also made it explicit during Interview 3 that he considered his increased confidence had contributed to the improvement of his teaching.

I’m more confident with it than I was before [doing EMIC] and I think that’s been really important. That’s improved my teaching, just gaining confidence in attacking it. (Alan, Interview 3, p. 3)
Attitude towards mathematics teaching

While at the commencement of the study Alan enthusiastically reported his love of teaching, he appeared anxious about teaching mathematics, and he openly expressed his need for “updating” in this area.

I’ve got updating to do [with respect to mathematics teaching] and that’s why I’m doing EMIC. Because things have definitely changed and it’s happened fairly quickly and I haven’t been teaching in a classroom in that time. (Alan, Interview 1, p. 7)

His anxiety appeared to be relieved across the time of the study, and he expressed increased enthusiasm and satisfaction with respect to his mathematics teaching.

I’m much happier, much happier [about teaching mathematics]. (Alan, Interview 2, p. 2)

I’m enjoying it [mathematics sessions] more and so are the kids. (Alan, Interview 2, p. 5)

I’m happier about it [my mathematics teaching] than I was [before being involved in EMIC]. (Alan, Interview 3, p. 3)

Alan identified a number of positive affects on students associated with his new practices. It appeared from some of his comments that these effects may have led him to develop a more positive attitude towards mathematics teaching.

It’s [the things I’m trying] being successful. The kids are really picking it up. ... I’ve liked watching that. I’ve enjoyed it. (Alan, Interview 2, p. 2)

They’re more interested in participating in the sessions as well. It’s not a chore, it’s fun. (Alan, Interview 2, p. 2)

The kids benefit so much from it, and that’s what it’s all about. And their attitude towards maths changes so much too. It’s no longer boring. (Alan, Interview 3, p. 7)

6.5 Critical factors associated with Alan’s professional growth

6.5.1 The importance of experimentation and reflection

As discussed in the previous section, the data collected provided evidence that Alan engaged in experimentation and reflection across the time of the study. Alan was observed exploring new strategies in his mathematics lessons and he enthusiastically reported the outcomes of his classroom experimentation and how those outcomes affected his views of mathematics teaching and learning.
Alan made explicit reference to his experimentation with the ideas presented to him in the EMIC program.

I did nearly all of those activities in here [EMIC logbook]. There were few that I didn’t use and if I felt that they were more for the infancy part well then I would modify them for my kids. (Alan, Interview 2, p. 1)

I feel like I’ve tried everything that I’ve been presented with. ... I’ve tried everything that was suggested. I don’t feel like I held back and not had a go. (Alan, Interview 2, p. 2)

While he made no direct references to having engaged in reflection, he made many comments that were themselves reflections on what he had experienced and learned. The following comments (cited in earlier sections), illustrate this type of reflection.

It really opened my eyes. ... It just made me realise that maths is really very different to what I thought it was, to what I always imagined it to be. (Alan, Interview 2, p. 1)

I’m more confident with it [my maths teaching] than I was before and I think that’s been really important, that’s improved my teaching, just gaining confidence in attacking it. (Alan, Interview 3, p. 3)

Alan’s comments revealed that, although his participation in EMIC was initially accompanied by reluctance, he valued his involvement in the program.

I’m really glad that I’ve done it. To start off with the thought of doing it filled me with horror because I studied last year and ... I thought Oh god! Do I need to be doing this? And it was a chore to turn up the first couple of times because I just wanted some time to myself. But it wasn’t that bad. I quite enjoyed it. (Alan, Interview 2, pp. 5–6)

It was great value to me. It has obviously affected my teaching. (Alan, Interview 3, p. 6)

I think it was great. I mean it was really worthwhile. It did a lot for me. (Alan, Interview 3, p. 7)

Similar observations were made by Tanya, the EMIC tutor. When asked to describe how the teachers benefited from participating in EMIC, she provided the following response in relation to Alan.

When he first came [to our school] ... he was just a book addict, and books from way, way back. And he thought that because of his entertaining personality that children were going to learn. ... I look at him now, and he’s right in teaching with Pam, who is such a reflective teacher, such a truly, truly excellent teacher, and he’s really holding his own. I think he was one person who benefited a huge amount. ... I think it moved him in a sense from nowhere to somewhere. I really do. (Tutor Interview, p. 5)
Tanya had worked very closely with Alan across each of the study time periods, and she attributed much of his growth to the way in which the EMIC program encouraged him to reflect on his teaching.

Tanya further reported that Alan’s involvement in EMIC encouraged him to become “part of the maths culture” at their school. Across the time of the study it appeared that in addition to engaging in classroom experimentation, Alan also explored another facet of professional practice—collegiality. He began to value opportunities to work with his colleagues to plan his mathematics teaching, and he became more involved in school activities related to mathematics.

I work closely with the teacher over the road [corridor] ... we plan together. (Alan, Interview 2, p. 5)

I don’t think there is enough of that kind of thing [in professional development]—just sharing ideas and stuff, because I think people always benefit from that kind of thing. ... I think the more you can help one another and the more ideas that you can be presented with the easier it is. (Alan, Interview 3, p. 1)

There’s a lot of sharing here, it happens all the time. (Alan, Interview 3, p. 3)

D.J. Clarke and Peter (1993) have already drawn attention to the importance of teacher reflection on experimentation in their empirical work in secondary school settings. The findings of this study with respect to Alan’s professional growth add further confirmation to the significance of reflection on experimentation as a major change sequence.

6.5.2 An environment conducive to change

In each of the time periods of the study, Alan made positive and consistent references to the school context in which he was working. In responses to the structured interviews and in informal discussions he referred to several different elements of his school environment that appeared to support him as he was involved in the process of professional development. These included: the school staff; and in particular the EMIC tutor; the resources and equipment available in the school; the mathematics ethos of the school; and the professional development culture evident in the school. Table 6.10 displays comments made by Alan that illustrate how he valued each of these supportive elements.
Table 6.10
Elements of Alan’s School Environment That Appeared Conducive To Change

<table>
<thead>
<tr>
<th>SCHOOL ENVIRONMENT ELEMENTS</th>
<th>RELATED COMMENTS MADE BY ALAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAFF AND EMIC TUTOR</td>
<td>There’s people. I’ve got Gail across the road [corridor] ... and there’s Tanya [EMIC tutor] downstairs. ... There are five people I work fairly closely with. (Alan, Interview 1, p. 3)</td>
</tr>
<tr>
<td></td>
<td>I’ve got a resource person here [Tanya] that I can go to anytime I need to. (Alan, Interview 3, p. 3)</td>
</tr>
<tr>
<td></td>
<td>There’s a lot of sharing here, it happens all the time. (Alan, Interview 3, p. 3)</td>
</tr>
<tr>
<td></td>
<td>There’s always someone there that we can ask questions of. (Alan, Interview 3, p. 5)</td>
</tr>
<tr>
<td>RESOURCES AND EQUIPMENT</td>
<td>It’s terrific me being here because I can just race up the stairs whenever I want to and grab what I need. It’s all there, and it’s well set out. (Alan, Interview 2, p. 4)</td>
</tr>
<tr>
<td></td>
<td>I think we’re lucky. We’ve got a great resource [Tanya], we’ve got a fantastic room, there’s always things that we can use, there’s always someone there that we can ask questions of. (Alan, Interview 3, p. 5)</td>
</tr>
<tr>
<td>MATHEMATICS ETHOS</td>
<td>I think our school is up to date ... People are happy following the EMIC approach. I mean it’s all happening here. (Alan, Interview 2, p. 5)</td>
</tr>
<tr>
<td></td>
<td>From what I can see everyone is doing real life maths and using the EMIC approach as much as possible. (Alan, Interview 3, p. 5)</td>
</tr>
<tr>
<td></td>
<td>I think the teaching of maths at this school is pretty good. ... Any changes necessary? I don’t think so. (Alan, Interview 3, p. 5)</td>
</tr>
<tr>
<td>PROFESSIONAL DEVELOPMENT CULTURE</td>
<td>Everybody else in the school has been EMICed. ... So everyone’s up to date. (Alan, Interview 2, p. 4)</td>
</tr>
<tr>
<td></td>
<td>Tanya even runs special nights here for the staff. (Alan, Interview 2, p. 4)</td>
</tr>
<tr>
<td></td>
<td>We have heaps of things here. We have FASPA, FAMPA, Key Group [Victorian professional development activities]. There’s always something happening here. (Alan, Interview 3, p. 2)</td>
</tr>
</tbody>
</table>

It was clear that the school environment in which Alan worked had a significant influence on his professional growth. When Alan arrived at School A, his mathematics teaching style was traditional in orientation, his teaching and assessment strategies repertoires were very limited, and it appeared unlikely that he would actively seek professional development in mathematics. However once his enthusiasm had been aroused through his participation in EMIC, the conditions that existed in School A were both supportive and encouraging of Alan’s development. The following comment made by Alan during Interview 3 (from which some excerpts were included in Table 6.10) highlights his positive view of his school environment.
I think the teaching of maths at this school is pretty good. I think we’re lucky, we’ve got a great resource, we’ve got a fantastic [maths] room, there’s always things that we can use, there’s always someone there that we can ask questions of. Any changes necessary? I don’t think so. (Alan, Interview 3, p. 5)

The significance of the school environment and its relationship to teacher professional growth will be discussed in Chapter 10.
Chapter 7
Phase Two: Examining teacher professional growth—
Stories of the other teachers

In this chapter, the professional growth of Anne, Beth, Brian, Cath and Debra is examined. As in Chapter 6, where Alan’s professional growth is reported, this chapter presents analyses of the data related to each teacher’s Classroom Practice using the Interconnected Model of Teacher Professional Growth to represent the teachers’ growth in this area across the time of the study. The material presented in this chapter, however, is intended to summarise each teacher’s professional growth. Illustrative examples are used to emphasise key aspects of the teachers’ growth. In the next chapter similarities and differences in the growth of all of the teachers involved in the study are explored.

7.1 The structure for reporting the teachers’ professional growth

The structure used to report the professional growth of Anne, Beth, Brian, Cath, and Debra is similar to that used in Chapter 6 to report Alan’s professional growth. Each teacher’s professional growth is discussed in four sections. These are:

- a contextual overview of the teacher’s professional history, environment and inclinations;
- the teacher’s Classroom Practice in each of the distinct time periods of the study;
- the teacher’s professional growth across the time of the study; and
- critical factors associated with the teacher’s professional growth.

Analyses of the classroom observation, interview, and questionnaire data are reported, and diagrammatic representations of the Interconnected Model are used to represent change sequences and growth networks associated with the teachers’ growth. Figure 7.1 presents an overview of the data collected in each of the periods of the study.
During the EMIC Program

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<th>OCT</th>
<th>NOV</th>
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Soon After the EMIC Program

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</tr>
<tr>
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<td>OBS 7 &amp; 8</td>
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10–12 Months After the EMIC Program

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<thead>
<tr>
<th>MAY</th>
<th>JUN</th>
<th>JUL</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

(* = end of school year)

INT = Interview; OBS = Observation; QST = Questionnaire

Figure 7.1. Overview of data collected in each of the study time periods.

In Figure 7.1 markers represent the approximate times when the three structured interviews were conducted and when the questionnaire was completed. Shaded regions represent the times when classroom observations took place. Obviously there was some variation in the times when each of these data collection activities took place.

All five teachers participated in the three structured interviews and completed the questionnaire. With respect to classroom observations, one teacher (Cath) was observed only seven times, and another (Brian) was observed only five times. Reasons for these variations are reported in the discussions of these teachers.

7.2 The story of Anne

7.2.1 Anne in context

Teaching background

Anne had 15 years teaching experience in primary schools when the study commenced. She had taught all levels from Grade 1 to Grade 6. Like Alan, Anne was in her first year teaching at School A when she became involved in the EMIC program. She was working with a Grade 3 class at that time. In the second year of the study Anne taught a composite Grade 1/2 class at the same school.
School context

Details of Anne’s school context are the same as those described for Alan (see Section 6.2.2).

Comments made by Anne during Interview 1 indicated that she also felt the mathematics ethos at School A was positive and strong.

The teachers here [School A] ... they’re so enthusiastic. And I think there is quite an emphasis on maths. And I think it sort of permeates to the children too, at least I hope it does. I’m sure the [school mathematics] policy must be good. (Anne, Interview 1, p. 6)

Anne's view of her mathematics teaching prior to EMIC

The description Anne provided of her mathematics teaching prior to EMIC indicated that her teaching was essentially “traditional” in orientation, however with some exploration of non-traditional teaching strategies. She described a typical mathematics lesson as consisting of teacher explanation, followed by practice and application in the form of individual worksheet tasks or small group tasks using materials.

I generally work with an explanation and then children have activities to do ... I’ll give them some worksheets ... or I’ll have some group of children on the floor working with materials, and a lot of oral work. (Anne, Interview 1, p. 2)

During Interview 1 Anne emphasised her belief in the importance of accuracy of mathematical results.

I expect a certain result—I don’t expect them [students] to make a wrong answer. ... I mean if there are different ways of tackling things that’s fine, I don’t expect them to all approach something in exactly the same manner, but I do expect that they give the correct answer. (Anne, Interview 1, p. 4)

While she regarded accuracy as important, another consideration that appeared important to her was allowing students to determine their own effective processes for working on mathematical tasks.

I try to pose a certain problem and try and get them to work out a way through it. (Anne, Interview 1, p. 4)

This comment, and others made by Anne during Interview 1 indicated that she was exploring some non-traditional mathematics teaching strategies.

I like them to use materials all the time and I encourage them to do that. Games, I like them to play games. I try and relate it to actual outside living so that if we are talking about any addition or
subtraction or any of those sort of things, I perhaps relate it to
money or buying lunch, that kind of thing. (Anne, Interview 1, p. 4)

Some of Anne’s comments with respect to different teaching strategies however, made
her motives for the use of these strategies appear questionable. For example:
Sometimes they work independently or in groups—it depends how I
feel. (Anne, Interview 1, p. 4)

Involvement in EMIC

Anne’s involvement in EMIC was positive but passive. During Interview 1 she
reported that she had heard EMIC—“was good” from staff at her previous school, and
that she was seeking a “wider range of experiences [activities] to present to the
children” (Anne, Interview 1, p. 1).

Like Alan, to some extent Anne was coerced into participating in EMIC (see
Section 6.2.4). At no time however did she express any reluctance with respect to her
involvement. Instead she spoke of how she considered the EMIC program would be of
value to her.

I’ve heard it’s interesting and that’s why I’m doing it. And it should
help me put into practice some ideas. … I’d like to know more about
it [mathematics teaching]. (Anne, Interview 1, p. 5)

7.2.2 Anne’s Classroom Practice

Vignettes and change sequences

Vignettes 7.1–7.8 provide outlines of the lessons observed in Anne’s classroom to set
the context for the discussion which follows.
Vignettes 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7 and 7.8
Vignettes of Lessons Observed: Anne

## During the EMIC Program

<table>
<thead>
<tr>
<th>VIGNETTE 7.1</th>
<th>VIGNETTE 7.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: Observation 1, June, Grade 3)</td>
<td>(Source: Observation 2, August, Grade 3)</td>
</tr>
<tr>
<td>Anne conducted a discussion with the whole class that reviewed ideas explored in the previous session with respect to symmetry. She then involved the students in two physical activities that had been presented during an EMIC session. The first (&quot;Maths In Motion&quot;) involved the exploration of odd and even numbers. The second (&quot;What's My Number?&quot;) involved the exploration of a variety of number concepts. Anne observed the students as they participated in the activities. To conclude the lesson Anne discussed with the students different number strategies used in the activities.</td>
<td>This lesson was part of a series of lessons related to a &quot;Space&quot; theme. Anne asked the students to calculate the price of a space person's outfit given different prices for each item of clothing, and to determine what would be the most/least expensive outfit they could have. The students worked independently using MAB materials to calculate their solutions. Anne encouraged them to use a calculator to check their calculations.</td>
</tr>
</tbody>
</table>

## Soon After the EMIC Program

<table>
<thead>
<tr>
<th>VIGNETTE 7.3</th>
<th>VIGNETTE 7.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: Observation 3, December, Grade 3)</td>
<td>(Source: Observation 4, December, Grade 3)</td>
</tr>
<tr>
<td>Anne presented an introductory activity she called &quot;quick maths&quot; which involved her asking the students a number of mixed operations questions. The students recorded solutions in their maths books and then, as a class, checked the solutions. Anne then conducted a whole class discussion on the theme &quot;Christmas&quot;. The discussion focused on purchasing and giving presents. Anne then asked the students to look through magazines to locate two gifts for people in their families and to record an estimate of the cost of the gifts. The students worked independently on this task for the remainder of the session.</td>
<td>This lesson had already begun when the observation commenced. Students were working independently at their desks on a number of calculations that Anne had set. They then discussed their solutions in small groups and added the total number correct to determine personal scores. Anne then conducted a discussion with the whole class related to the collation of the results of a &quot;Christmas&quot; survey completed the previous day. Small groups reported findings of different survey topics and Anne recorded their findings on a class chart that had been prepared the day before.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VIGNETTE 7.5</th>
<th>VIGNETTE 7.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: Observation 5, March, Grade 1/2)</td>
<td>(Source: Observation 6, April, Grade 1/2)</td>
</tr>
<tr>
<td>This lesson started with a range of whole class oral counting activities. Anne then asked the Grade 2 students to complete six tasks related to counting objects around the room (these were presented on a worksheet in the form of a number trail). As the students worked independently on those tasks, Anne worked with all of the Grade 1 students on counting and ordering activities. The Grade 1 students used Unifix materials for these activities. Towards the end of the session Anne brought all of the students together to discuss their strategies and ideas.</td>
<td>This was the second lesson in a sequence on making and measuring boxes. Anne first involved the class in a discussion reviewing information related to the making of boxes the previous day. She then challenged the students to measure their boxes using general materials that she provided. The students worked in groups to determine the measurements of the boxes, using materials such as streamers, plastic sticks, rods, and butcher paper. Anne observed the groups as they worked on the task and asked questions with respect to their selection of materials and the processes they were using. The conclusion of the lesson was not observed, however Anne stated that her intention was for each group to report their findings.</td>
</tr>
</tbody>
</table>
10–12 Months After the EMIC Program

**VIGNETTE 7.7**
(Source: Observation 7, June, Grade 1/2)

To begin this session Anne conducted a whole class discussion related to a large map that the class had previously made. The map represented the setting (location) of the story Little Red Riding Hood. Anne asked the students to cut and paste “groups of” objects that could be placed on the map. For example a group of three trees. The students worked in pairs on the tasks which were listed on a worksheet. The students did not complete the tasks in the time available, so Anne stated that they would continue this work in the next maths session.

**VIGNETTE 7.8**
(Source: Observation 8, June, Grade 1/2)

As in Observation 5, Anne used a range of whole class oral counting activities to introduce this session. She then involved the students in a physical activity where she distributed cards with digits and operation symbols and asked the students holding the cards to create equations. The students then worked at their tables to fold a piece of paper into a 4x2 grid for playing bingo. Anne encouraged the students to discuss what they knew about “halves” as they folded the paper to make the grids. The students were then asked to record the “two times” tables in the spaces on their grids. They then played bingo. To conclude the lesson Anne conducted a whole class number game (Buzz).

Figure 7.2 displays an overview of the change sequences associated with Anne’s professional growth in the different study time periods. A discussion specific to each of these periods is presented below.

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During the EMIC Program

The data collected provided evidence that this was a period of exploration for Anne with respect to two of the components of Classroom Practice. Anne engaged in classroom experimentation with Teaching Strategies and Resource Use ideas that were presented in EMIC sessions.
Exploring Teaching Strategies

During Observation 1 (see Vignette 7.1), Anne involved her students in physical activities ("Maths In Motion" and "What's My Number?"), a strategy which had been presented during an EMIC session. Anne encouraged her students to discuss the particular number strategies they used as they participated in these activities. The "discussion" of students' mathematical strategies was emphasised by Tanya, the EMIC tutor, during the EMIC sessions, and it was emphasised in the EMIC program documentation (see Ministry of Education, 1990a).

Exploring Resource Use

During Observation 2 (see Vignette 7.2), Anne encouraged students to use MAB materials and calculators as they worked on a task involving calculating costs. Anne later reported (during Interview 2 in the period soon after the EMIC program) that she had not previously used calculators with her students, and stated that she had learned how to make use of them at EMIC.

Calculators I have changed. In fact I don't know that I even used those before [EMIC] really. (Anne, Interview 2, p. 3)

A note about Anne's Assessment Strategies in this period

Anne made few comments with respect to assessment during Interview 1. She appeared uneasy about discussing this area. Her comments indicated that she did not have an organised procedure for assessing students' mathematics learning, but that she was aware of some informal assessment strategies.

Well I suppose it's not very formal at the moment. I'm looking and I watch to see if they understand what they're doing and make an assessment that way. ... [I use] anecdotal records, that sort of thing.
(Anne, Interview 1, p. 6)

During the lessons observed in her classroom in this period, Anne observed individual students as they participated in tasks and questioned them when she felt it was appropriate. While there is no conclusive evidence in the available data from this period to confirm whether Anne's use of these strategies is directly linked to her participation in EMIC, it is likely that the emphasis given to them in the EMIC program acted as a stimulus for her use of these strategies.
Soon After the EMIC Program

The data collected soon after the EMIC program provided evidence that Anne explored some further Teaching Strategies and Resource Use ideas presented during EMIC sessions, and that she reflected on her classroom experimentation. There was evidence that Anne reflected on the classroom practicalities of the new Teaching Strategies and Resource Use ideas she was exploring. There was also evidence that Anne interpreted certain classroom behaviours associated with her use of new Teaching Strategies as salient outcomes. Further, it appeared that Anne reflected on the content of the EMIC program with respect to Assessment Strategies.

Exploring and reflecting on Teaching Strategies

When asked, during Interview 2, if she had tried any "new" teaching strategies in mathematics sessions as a result of participating in EMIC, Anne described an outdoor activity that focused on the concept of circumference.

I took them outside .... I wanted to do the circumference and I thought it could relate to the sizes of planets vaguely. So we went out and did one of those MCTP ones [activities from the resource MCTP] on circumference, where children work in pairs and they have a long piece of string and they have to walk around and then relate it to the radius. (Anne, Interview 2, p. 3)

In reflecting on her experimentation with this strategy, Anne interpreted positive student responses as indicators of enjoyment and learning.

They had a marvellous time, they really loved it. It did mean a lot to them too. They were able to see how it related ... it was a meaningful exercise I felt. (Anne, Interview 2, p. 3)

During this period Anne also reflected on the practicalities associated with her classroom experimentation. The following excerpt from Interview 2 provides an example of this—Anne perceived a change in her ability to relate mathematics lessons to real life situations.

I have developed my ability to relate real life situations, or relate maths to real life situations more—in a deeper way and a better way perhaps. (Anne, Interview 2, p. 1)

Exploring and reflecting on Resource Use

During Observations 3 and 6 conducted in this period (see Vignettes 7.3 and 7.6), Anne made use of specific resources emphasised by Tanya during EMIC sessions. These included magazines in Observation 3, and boxes and packages in Observation 6.
The use of everyday materials such as these for mathematics teaching and learning is emphasised throughout the EMIC program.

In addition to exploring ideas related to Resource Use in her classroom, Anne also reflected on what she had learnt with respect to Resource Use. For example, in reflecting on her classroom experimentation with calculators, Anne reported that prior to her participation in EMIC she was unaware of how to use calculators effectively.

I wasn’t sure how to use them [calculators—in the classroom]. I feel quite happy with them [now]. I mean I always felt that they were sensible and valuable but I didn’t know how to make the most of them. (Anne, Interview 2, p. 3)

Reflecting on Assessment Strategies

During this period, Anne’s apparent uneasiness with respect to her assessment of students’ mathematics learning became more obvious. During Interview 2 she spoke directly of her concerns with respect to assessment.

I find it quite hard to assess them [students] in the EMIC way. I find that difficult. I’m not good enough at that I feel. I’m perhaps not confident enough. I mean I have always jotted a few notes and things down, but not to such a degree like I think is required by the EMIC program. I need more practice in that area. (Anne, Interview 2, p. 4)

Anne stated that she felt she had obtained enough information from the EMIC program to make changes to her assessment practice, but was unable at this time to put her new ideas into practice due to lack of confidence.

I mean the tests and things [assessment ideas] we were shown, well it’s all there. It’s just a matter of using what’s there. I see it as good to have more than one way of testing [assessing] children so that you can get your own ideas and report to parents. It’s just that I think I’m just not confident enough as yet. I need more just to keep on going in that area. (Anne, Interview 2, p. 4)

In each of the four classroom lessons observed during this period, Anne continued to observe students as they worked on tasks. However, at no time did she record student assessment information in any form. In addition, Anne made no mention of assessment during any informal discussions in this period.

Ten to Twelve Months After the EMIC Program

The period 10–12 months after the EMIC program was characterised by the application of Anne’s new knowledge and beliefs to her ongoing practice. During this period she continued to engage in reflection and she consolidated her changed practice.
Applying and reflecting on Teaching Strategies

During Observations 7 and 8 (see Vignettes 7.7 & 7.8) Anne applied a number of the teaching strategies that were presented during EMIC sessions. The new strategies that Anne applied included: group and pairs (student groupings); practical tasks, physical activities and games (task types); and story shells and literature (contexts). Of particular note was Anne’s use of a range of teaching strategies in single lessons in this period. When the study commenced, Anne tended to use fewer strategies in combination in the lessons observed (for example see Vignettes 7.1 & 7.2).

In reflecting on her changed practice, Anne commented on positive outcomes for herself and her students.

It’s more fun doing it that way. Everyone enjoys it that way. I enjoy it and the children enjoy the activities. (Anne, Interview 3, p. 2)

Applying and reflecting on Resource Use

During this period Anne reported that she was more aware of available resources, and ways of using them, than she was prior to her involvement in EMIC.

I think I’m more aware of what’s around me, and I make use of those .... (Anne, Interview 3, p. 3)

During lessons observed in this period, Anne used a number of resources specifically referred to during EMIC sessions—for example general materials including magazines, stickers and cards (see Vignettes 7.7 & 7.8).

Applying and reflecting on Assessment Strategies

It appeared that in this period Anne used some alternative assessment strategies (in particular observation and questioning during Observation 7—see Vignette 7.7). In addition, her confidence with respect to assessing student performance in mathematics appeared to increase.

I use a combination of anecdotal records [observations] and tests. (Anne, Interview 3, p. 4)

It’s [using informal strategies] more acceptable ... more comfortable. (Anne, Interview 3, p. 4)

I’m certainly much more confident in that area [assessment]. (Anne, Interview 3, p. 4)
Overview of changes in Anne's Classroom Practice

Table 7.1 displays an overview of the strategies and resources explored by Anne (these include both strategies and resources that were new to her mathematics teaching, and familiar strategies and resources that she used in new ways), and an overview of her changed knowledge and beliefs (in particular, new knowledge and beliefs).

Table 7.1
Anne's Classroom Practice: Overview of Strategies and Resources Explored and Changed Knowledge and Beliefs

<table>
<thead>
<tr>
<th>CLASSROOM PRACTICE COMPONENT</th>
<th>STRATEGIES AND RESOURCES EXPLORED</th>
<th>CHANGED KNOWLEDGE AND BELIEFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEACHING STRATEGIES</td>
<td>Student groupings</td>
<td>- awareness of new strategies for teaching mathematics</td>
</tr>
<tr>
<td></td>
<td>- whole class</td>
<td>- awareness of the need to use a variety of strategies for teaching mathematics</td>
</tr>
<tr>
<td></td>
<td>- groups</td>
<td>- awareness of the efficacy of teaching strategies explored</td>
</tr>
<tr>
<td></td>
<td>- pairs</td>
<td></td>
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<tr>
<td></td>
<td>Discourse types</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- discussion</td>
<td></td>
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<tr>
<td></td>
<td>Task types</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- physical activities</td>
<td></td>
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<tr>
<td></td>
<td>- problem solving/open ended tasks</td>
<td></td>
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<tr>
<td></td>
<td>- games</td>
<td></td>
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<td></td>
<td>- practical tasks</td>
<td></td>
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<tr>
<td></td>
<td>Contexts</td>
<td></td>
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<tr>
<td></td>
<td>- theme work</td>
<td></td>
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<td></td>
<td>- story shells</td>
<td></td>
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<tr>
<td></td>
<td>- literature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- none explored</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Note: Anne used a range of teaching strategies in single lessons]</td>
<td></td>
</tr>
<tr>
<td>RESOURCE USE</td>
<td>Commercial publications</td>
<td>- awareness of new resources for teaching mathematics</td>
</tr>
<tr>
<td></td>
<td>- no new publications explored</td>
<td>- awareness of new ways of using familiar resources</td>
</tr>
<tr>
<td></td>
<td>School based publications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- charts</td>
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<tr>
<td></td>
<td>Mathematics teaching and learning equipment and materials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- no new equipment explored</td>
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<tr>
<td></td>
<td>Technology</td>
<td></td>
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<td></td>
<td>- calculators</td>
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<td></td>
<td>General materials</td>
<td></td>
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<tr>
<td></td>
<td>- magazines/catalogues</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- boxes/packaging</td>
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<tr>
<td></td>
<td>- streamers, stickers, matchsticks</td>
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<tr>
<td></td>
<td>Human resources</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- colleagues</td>
<td></td>
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<tr>
<td></td>
<td>- EMIC tutor</td>
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<tr>
<td>ASSESSMENT STRATEGIES</td>
<td>Measurement strategies</td>
<td>- awareness of new strategies for assessing student learning in mathematics</td>
</tr>
<tr>
<td></td>
<td>- observation</td>
<td>- awareness of the need to use a variety of assessment strategies in mathematics</td>
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<tr>
<td></td>
<td>- questioning</td>
<td></td>
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<tr>
<td></td>
<td>Recording strategies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- anecdotal records</td>
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</tbody>
</table>
Anne explored several strategies and resources that were presented during the EMIC program (see Table 7.1). Her explorations in each area of Classroom Practice led her to develop some new knowledge and beliefs. In addition she applied some strategies and resources as part of her regular mathematics teaching practice. The changes in Anne’s practice that were enduring and therefore represent growth are described in the next section.

7.2.3 Anne’s professional growth

This section describes key aspects of Anne’s professional growth with respect to each component of Classroom Practice, and the growth networks associated with that growth. Figure 7.3 displays an overview of Anne’s growth networks with respect to each Classroom Practice component. Each of these components is discussed below.

![Figure 7.3](image)

*Figure 7.3. Anne’s growth networks: Classroom Practice.*

**Growth with respect to Teaching Strategies**

Anne’s growth with respect to Teaching Strategies appeared to have been stimulated by her enactment in her classroom of the ideas presented during EMIC sessions. Anne’s classroom experimentation with several new teaching strategies, and the reflection on that experimentation, led her to incorporate several new strategies into her ongoing mathematics teaching practice. Key aspects of Anne’s growth with respect to Teaching Strategies included:

- knowledge of new strategies for teaching mathematics;
- an extended repertoire of teaching strategies;
- new beliefs related to the need to use a variety of strategies; and
- new beliefs related to the efficacy of teaching strategies explored.
Growth with respect to Resource Use

Anne explored the use of several resources presented during EMIC sessions in her classroom. She also reflected on the nature of her experimentation with respect to Resource Use, and applied some Resource Use strategies in her ongoing teaching practice. It appeared that Anne was primarily concerned with which resources to use, and how to use them (i.e. the nature of her resource use), rather than the consequences of her Resource Use. Key aspects of Anne’s growth with respect to Resource Use included:

- knowledge of new resources for teaching mathematics; and
- knowledge of new ways of using resources for teaching mathematics.

Growth with respect to Assessment Strategies

Rather than directly explore the assessment strategies presented during EMIC sessions in her classroom, Anne appeared to first reflect on the assessment ideas presented. She later applied them in practice, and then reflected on the nature of that practice. As a result, Anne changed some of her beliefs with respect to assessing student performance in mathematics. Key aspects of Anne’s growth with respect to Assessment Strategies included:

- knowledge of new strategies for assessing student learning in mathematics; and
- new beliefs related to the assessment of student learning in mathematics.

Overall growth network associated with Anne’s Classroom Practice

Figure 7.4 displays the overall growth network associated with Anne’s growth with respect to Classroom Practice.

\[\text{Figure 7.4.} \quad \text{Anne's overall growth network with respect to Classroom Practice}\]
It appeared that Anne was more concerned with the practicalities associated with changing her Classroom Practice (that is, how to implement changes), rather than the consequences (or outcomes) associated with changing her practice.

Other aspects of growth

The data collected provided evidence that Anne also demonstrated and reported some growth with respect to certain general aspects of her mathematics teaching. During the lessons observed in her classroom, Anne appeared more relaxed about, and confident with, her mathematics teaching. During Interview 3 she attributed her increased confidence to her participation in EMIC.

It [EMIC] made me much more confident about teaching maths and probably more relaxed about it actually, yes more confident and more relaxed. (Anne, Interview 3, p. 6)

Another associated area of growth for Anne related to her attitude towards her mathematics teaching. During Interview 3 Anne spoke openly of her increased enjoyment in her mathematics teaching.

[There's] more enjoyment in it [teaching maths]. It's more fun doing it that way. Everyone enjoys it that way. I enjoy it and the children enjoy the activities. (Anne, Interview 3, p. 2)

It [participating in EMIC] has helped me to be much happier in teaching maths. I really like it. It's good fun. (Anne, Interview 3, p. 5)

Anne also demonstrated lasting changes in her expectations of students with respect to mathematics. Anne felt that she had higher expectations of students since completing EMIC, and this was reflected in the kinds of learning tasks in which she involved her students.

Well I might expect the children to be able to do things now that I perhaps wouldn't have expected before. For example, when we made boxes, I collected a whole pile of different boxes and put them in front of the children, and let them find the net of each box. And then I got them to choose one to copy, to make. So they made some fantastic things. They actually did a wonderful job with that and I was really pleased with it. I thought for little children in grade one to do such a good job is quite amazing. So that, I suppose, is more of a greater expectation on my part. Putting things in front of them and letting them go through it themselves before, or without having to put any enormous input in myself—they are able to come out with it themselves. (Anne, Interview 3, p. 2)

Anne's changed expectations of students appeared to be directly associated to her classroom experimentation with some of the ideas presented during EMIC sessions.
7.2.4 Critical factors associated with Anne's professional growth

The importance of experimentation

It appeared, from the analysis of the data collected, that Anne's experimentation with the ideas presented in the EMIC program was a critical factor in her professional growth. Her classroom explorations led her to develop knowledge and understanding with respect to how to use new strategies, and this appeared to give her the confidence to apply them as part of her regular teaching practice. While Anne's reflection on her classroom experimentation obviously led to her increased knowledge and confidence with the new strategies she explored, she appeared to engage in little reflection with respect to the consequences associated with her changed practice. It was only with respect to Teaching Strategies that Anne seemed to consider the consequences of her classroom experimentation (see Section 7.2.2).

The importance of the school environment

Like Alan, Anne appeared to value the supportive environment that she experienced at School A. While she spoke in less detail than Alan did, she identified similar key elements of the environment of School A that appeared to support her professional growth. These included: the enthusiasm, collaboration and involvement of the school staff, and in particular, the EMIC tutor; the resources and equipment available in the school; and the positive and strong mathematics ethos in the school. The following excerpts from each of the interviews conducted across the time of the study illustrate Anne's appreciation of these elements.

The attitude of the teachers here [School A], it looks good. They're so enthusiastic that I think there's quite an emphasis on maths. And I think it sort of permeates to the children too. At least I hope it does. I'm sure the policy must be good. That's how I would like my teaching to be, in that style. (Anne, Interview 1, p. 6)

I think it's working well here, the maths. The whole approach to maths is good. And the different activities, the whole school activities that we have work well. ... The whole school takes part and thoroughly enjoys it. (Anne, Interview 2, p. 4)

I would say that everybody here [School A] enjoys maths. ... We know that everyone has the same sort of approach basically with the EMIC teaching. We know that there are people that we can turn to who are very happy to help. We have huge sort of whole school days which are great fun for everybody. The children just love
them. I think it’s a much happier approach, a very happy approach to maths in the school. (Anne, Interview 3, p. 4)

The importance of the school environment to teacher professional growth is discussed further in Chapter 8.

7.3 The story of Beth

7.3.1 Beth in context

Teaching background

When the study commenced Beth had three and a half years teaching experience in primary schools. She had previously taught Grade 1, composite Grade 3/4, and composite Grade 5/6 classes. Beth had taken 12 months leave from the teaching service prior to the year in which the study began.

Beth was in her first year teaching at School B when she became involved in EMIC. She taught a Grade 4 class at that time. In the second year of the study Beth taught a composite Grade 4/5 class at the same school.

School context

School B, which was located in an inner suburb of Melbourne, had a student population of 280 and 11 full time teaching staff.

Participation in the EMIC program was a high priority for the school. Seven members of the teaching staff, including the principal, participated in the EMIC course investigated in this study. Mathematics was the main focus of the school’s curriculum improvement plan at the time the study took place, and the commitment to staff professional development in mathematics was strong. Few staff had been involved in any recent professional development with respect to mathematics. Because of the high level of staff involvement in EMIC, mathematics was developing a high profile within the school. Across the time of the study mathematics became the focus of many structured and informal discussions among the staff. In addition, a team of staff reviewed and refined the school’s mathematics policy.
Beth's view of her mathematics teaching prior to EMIC

Comments made by Beth during Interview 1 indicated that she was in an "experimental" stage with respect to her mathematics teaching. She appeared to be aware of, and to value, several non-traditional strategies, and she reported that she was exploring some of these in her mathematics teaching. Particular areas that Beth reported she was exploring included: different student groupings (with a focus on small group work); different task types (including problem solving, practical tasks and games); and different contexts (including theme work and integrated units). Beth also reported that she was exploring alternative assessment strategies including observation and questioning, and practical assessment tasks.

During Interview 1 Beth stated that she was uncertain of how best to organise her mathematics teaching and learning program. She viewed the approach she was using when the study commenced, which involved a combination of traditional and non-traditional methods, as exploratory.

Whether it works I don’t know. I’m trying it. ... We’re getting there.
It will take a while. I’ll have to see how it goes, monitor it and see
if it’s manageable. ... So we’ll see. (Beth, Interview 1, p. 3)

Involvement in EMIC

Beth appeared highly motivated to participate in EMIC. She openly expressed a desire to learn more about teaching, and in particular mathematics teaching.

I just want to be open to other ideas on how to teach maths, because ...
I see lots of faults in my teaching. I’ve done things and I’m doing things and I want to know more about what to teach and how to teach. And about evaluation. And the more I see, the more I can ...
well, if you don’t see it you can’t make any changes but if you do then you’ve got the opportunities to make those changes. I hope that ...
the changes I make can be positive.
(Beth, Interview 1, p. 9)

Beth stated that she hoped the EMIC program would provide: practical ideas for use in her classroom; opportunities to talk with, and learn from, other teachers; current information with respect to mathematics education; and personal inspiration.
### 7.3.2 Beth’s Classroom Practice

#### Vignettes and change sequences

Vignettes 7.9–7.16 provide outlines of the lessons observed in Beth’s classroom to set the context for the discussion which follows.

Vignettes 7.9, 7.10, 7.11, 7.12, 7.13, 7.14, 7.15 and 7.16  
Vignettes of Lessons Observed: Beth

<table>
<thead>
<tr>
<th>VIGNETTE 7.9</th>
<th>VIGNETTE 7.10</th>
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<tbody>
<tr>
<td><strong>During the EMIC Program</strong></td>
<td><strong>During the EMIC Program</strong></td>
</tr>
<tr>
<td>(Source: Observation 1, May, Grade 4)</td>
<td>(Source: Observation 2, August, Grade 4)</td>
</tr>
<tr>
<td>In this lesson Beth organised the students into groups to work on four different kinds of tasks: a &quot;pure number&quot; worksheet; an applied measurement task; an independent automatic response task; and miscellaneous problem solving tasks. The students worked on one of these task types during the lesson, and they were to rotate through the different tasks in the following three lessons. Many materials were available for students to use to complete the tasks. The students worked on the tasks for 40 minutes. Beth moved around observing each group as they worked. She then conducted a whole class discussion related to an MCTP (Lovitt &amp; D.M. Clarke, 1988) activity focused on collections and probability (&quot;Only A Matter of Time&quot;).</td>
<td>Beth introduced this lesson by demonstrating how to make a die from a net. She used the die to demonstrate how to play the game “Double Digit”. The students then played the game in small groups. Beth then introduced an activity focused on number and shape patterns, and asked the students to work independently to explore some problem solving tasks with respect to patterns. The students worked on these tasks for the remainder of the lesson. Beth observed the students as they worked and recorded anecdotal notes. Those students who completed the tasks were encouraged to play commercial mathematics games.</td>
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<table>
<thead>
<tr>
<th>VIGNETTE 7.11</th>
<th>VIGNETTE 7.12</th>
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<tbody>
<tr>
<td><strong>Soon After the EMIC Program</strong></td>
<td><strong>Soon After the EMIC Program</strong></td>
</tr>
<tr>
<td>(Source: Observation 3, October, Grade 4)</td>
<td>(Source: Observation 4, November, Grade 4)</td>
</tr>
<tr>
<td>During this lesson Beth and one of the other teachers involved in this study, Brian, combined their classes and taught together. Beth and Brian planned and prepared four different tasks related to fractions. This was the second lesson in a sequence of lessons to complete these tasks. They introduced the lesson by reviewing the tasks and the procedure for the students to work on them. The students worked in groups on one task for 15 minutes then moved to a second task. Beth and Brian observed the groups as they worked and asked questions when they considered it appropriate. Towards the end of the session Beth and Brian asked the groups to make a self-assessment with respect to the processes they used, and their outcomes.</td>
<td>The introduction to this lesson was not observed. Beth stated that she had organised the students into three groups to work on different number tasks. The groups were to spend 15 minutes on each task and then rotate. Within each of the groups the students worked independently or in pairs to complete the tasks. The tasks were presented on worksheets and focused on calculations, estimation and problem solving. Beth worked on the floor with a group of students who identified themselves as needing assistance with the calculations. She asked them to describe their difficulties, then worked with them on those areas, using concrete materials as needed. Towards the end of the session Beth asked them to assess their own level of improvement.</td>
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</table>
Soon After the EMIC Program (cont.)

<table>
<thead>
<tr>
<th>VIGNETTE 7.13</th>
<th>VIGNETTE 7.14</th>
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</thead>
<tbody>
<tr>
<td><strong>(Source: Observation 5, March, Grade 4/5)</strong></td>
<td><strong>(Source: Observation 6, April, Grade 4/5)</strong></td>
</tr>
<tr>
<td>Beth introduced this lesson by posing a problem related to water use in the students’ homes. She discussed with the whole class different uses of water, and then she and the class classified these uses. Beth challenged pairs of students to estimate how much water is used in the home, and to determine approximate measures used. The student pairs worked on this task then reported their results. Beth introduced the concept of variables with respect to water use (for example seasons). She then provided the students with copies of water use statistics from the state water board. Beth then discussed with the students ideas related to the measurement of volume. She used a range of materials including measuring jugs, MAB, and milk cartons to demonstrate and compare capacities. She then posed a problem with respect to the volume of the classroom. The students used calculators to find solutions to the problem posed.</td>
<td>This lesson began with Beth demonstrating the game of NIM using a calculator. Students then played the game in pairs. Beth then encouraged the students to participate in a variety of calculator activities (from the reference “Press On”). These activities focused on place value, addition and subtraction. Beth then distributed a worksheet with questions that had missing numbers. The students were required to use calculators to find and record the missing numbers.</td>
</tr>
</tbody>
</table>

10–12 Months After the EMIC Program

<table>
<thead>
<tr>
<th>VIGNETTE 7.15</th>
<th>VIGNETTE 7.16</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Source: Observation 7, June, Grade 4/5)</strong></td>
<td><strong>(Source: Observation 8, July, Grade 4/5)</strong></td>
</tr>
<tr>
<td>This lesson was one in a series related to a unit of work on the theme “Islands”. The students worked in groups to create treasure maps with grid coordinates identifying the location of a hypothetical treasure on a 3 dimensional model of an island they had prepared. The students used string to physically model the grids across the 3-D islands, and then drew them on poster paper to represent a treasure map. Towards the end of the lesson Beth discussed strategies the students were using emphasising the importance of communicating measurements accurately.</td>
<td>To begin this lesson Beth asked the students to draw four living creatures and then to estimate which of their creatures would live (the closest to) approximately 1 000 000 seconds. Beth discussed with the class ways to find solutions to this question and she provided them with information related to animal life spans. The students used calculators to determine the number of seconds in one day and then the average number of seconds in each creature’s life. Beth demonstrated this process with the whole class. She stated that they would continue work in this area in the next lesson. She then discussed with the students the relationship between multiplication and division. The students then completed a worksheet that included multiplication and division questions.</td>
</tr>
</tbody>
</table>

Figure 7.5 displays an overview of the change sequences associated with Beth’s professional growth in the different study time periods. Each of these periods is discussed below.
During the EMIC Program

During this period Beth engaged in classroom experimentation with Teaching Strategies, Resource Use and Assessment Strategies ideas that were presented in EMIC sessions. There was evidence that Beth also reflected on her exploration of Teaching Strategies.

Exploring and reflecting on Teaching Strategies

During Observation 1 (see Vignette 7.9), Beth explored a strategy that was new to her mathematics teaching. She organised the students into four groups to work on different mathematics tasks. One of the tasks had been presented at an EMIC session. It involved the students making a clock that displayed a nominated time. During an informal conversation at the end of the lesson, Beth explained that she considered the use of student groups to be a worthwhile strategy, but previously she had lacked confidence in organising and supervising different group tasks. She reported that this was the first time she had organised the students into groups in mathematics, and she said she was encouraged to try it after it was discussed at an EMIC session (Beth, Fieldnotes, Observation 1).

During Interview 1, Beth reflected on her exploration with respect to this grouping strategy noting some associated difficulties.

> At the moment it’s quite hard with group work. The children don’t like to cooperate in groups. I’ll see how it goes, monitor it, and see if it’s manageable. (Beth, Interview 1, p. 3)

It can be inferred from this comment that Beth intended to further explore group work in her classroom.
Exploring Resource Use

During Observations 1 and 2 (see Vignettes 7.9 & 7.10), Beth made use of a variety of equipment and materials, and a variety of resources for planning her lessons. Resources that were new to Beth with respect to her mathematics teaching included a number of general materials for the clock task in Observation 1 (including cardboard pieces, boxes, packages, tape), and the use of problem solving boxes made at the school. During Interview 1 Beth reported that she was unhappy about following the course guides at School B because she felt they were inadequate. She suggested that she considered it more appropriate to make use of a range of resources for planning. The use of a variety of resources for teaching mathematics was emphasised throughout the EMIC program.

Exploring Assessment Strategies

When Beth spoke of her assessment practices during Interview 1 in this period, she referred to some formal strategies that she had used for some time (including testing, marking student work, and checklists), and in addition she reported that she was exploring some alternative strategies presented during EMIC sessions.

At the moment I'm into asking them [students] what they know.
(Beth, Interview 1, p. 7)

Observations in Beth's classroom during this period provided evidence of Beth's exploration with strategies including: observation of students; questioning of students; and keeping anecdotal records.

Soon After the EMIC Program

The data collected provided evidence that soon after the EMIC program Beth explored some further ideas presented during EMIC sessions, and that she reflected on her classroom experimentation. In particular, Beth appeared to reflect on the classroom practicalities of the new ideas she was exploring. There was also evidence that Beth began to apply some new Teaching Strategies and Resource Use ideas to her ongoing classroom practice.

Reflecting on and applying Teaching Strategies

Beth reflected on the practicalities associated with her experimentation with different teaching strategies. She reported that there were no teaching strategies presented in EMIC with which she was totally unfamiliar. However there were several strategies that she did not know how to use to teach mathematics.
I’m a fairly recent teacher so I’ve heard and there was nothing brand
new that I didn’t know anything about, but to remind yourself and
show you ... how to use them [strategies] more coherently ... in
maths, which is an area you don’t tend to think of that way.
(Beth, Interview 2, p. 2)

Beth suggested that EMIC provided both stimulus and support to explore different
teaching strategies in mathematics. She stated that EMIC forced her and other staff
members “to think about new ways of planning and planning together”
(Beth, Interview 2, p. 2). She also considered that it legitimised certain kinds of
strategies that she was interested in applying.

It’s given me more legitimacy for doing activity based maths.
(Beth, Interview 2, p. 2)

During Interview 2, Beth reported the application of a wider variety of teaching
strategies in her ongoing practice.

I use a wider range of things. (Beth, Interview 2, p. 3)

Observations in Beth’s classroom throughout this period substantiated this claim.
Beth was realistic, however, in noting that there was more that she wanted to do in
this area.

There’s a lot of things I want to try, it’s just you can’t do it all at once.
And that’s what’s difficult. And I’m not going to because I can only
cope with so much at a time. ... Things [I haven’t yet explored] will
just come I think with time. (Beth, Interview 2, p. 4)

Exploring, reflecting on and applying Resource Use

During classroom lessons observed in this period Beth explored the use of calculators,
children’s literature, and a wider variety of general materials for teaching mathematics.
During Interview 2, she attributed her exploration of these resources to her involvement
in EMIC.

It’s [EMIC] given me ... information and [ideas] to use for example
books [literature]. I maybe wouldn’t have looked so easily at it
before ... (Beth, Interview 2, p. 2)

Beth also reflected on her experimentation with resources in her classroom. In
particular, she noted her increased awareness of resources and her new knowledge of
how to use them.

Previously, I did a lot of worksheets myself, purely because I didn’t
have many resources .... But there’s a lot more things available ... if
you know where to look you can cater for everybody.
(Beth, Interview 2, p. 4)
It's [EMIC] forced me to see other things [uses for resources]. (Beth, Interview 2, p. 4)

In addition, Beth reported that she was applying many of the ideas learnt with respect to Resource Use as part of her regular mathematics teaching practice.

I have used a lot more of the MCTP and I've also used Nursery RIME [resource books referred to during EMIC] and all those sorts of things .... And to be honest I wasn't aware of all that previously and they're excellent activities. (Beth, Interview 2, p. 2)

I use a wider range of things within my classroom to cater for all different abilities, and because I've got bigger [more] resources it enables you to do it better. (Beth, Interview 2, p. 3)

Exploring and reflecting on Assessment Strategies

During Observations 3 and 4 in this period (see Vignettes 7.11 & 7.12), Beth explored a new assessment strategy, student self-assessment. During Observation 3, Beth and Brian (who were team teaching together) asked student groups to assess their own performance, focusing on the processes used in their investigations, and the outcomes of those investigations. During Observation 4 Beth asked students who had identified themselves as having difficulties with calculations, to describe the nature of the difficulties and then to work with her on those areas. She then asked them to assess their own level of improvement.

During Interview 2, Beth reported that her awareness of alternative strategies for assessing student performance had increased through her involvement in EMIC.

That's [EMIC] forced me, well made me more aware that there are other ways to do it [assess students]. (Beth, Interview 2, p. 5)

She also pointed out that she regarded the EMIC program as the stimulus for her exploration of different assessment strategies.

I've been trying hard to use anecdotal [records], that's something I force myself to do maybe because of EMIC. (Beth, Interview 2, p. 5)

Ten to Twelve Months After the EMIC Program

This period was characterised by the application of Beth's new knowledge and beliefs to her ongoing practice. During this period she continued to engage in reflection and she consolidated her changed practice.
Applying and reflecting on Teaching Strategies

During Observations 7 and 8 (see Vignettes 7.15 & 7.16) Beth applied a number of the teaching strategies that were presented during EMIC sessions. In particular the new strategies she made use of included: groups; open ended tasks and projects; and theme work.

During Interview 3, Beth directly reported her application of the strategies she had learned about through participating in EMIC.

I have more activities [and strategies] than I previously had in all areas of maths .... It's made me feel better about it, offered me more ... and legitimised it. I use the EMIC kinds of activities more regularly. (Beth, Interview 3, p. 2)

During this interview, she also reflected further on how she valued her involvement in EMIC because it legitimised strategies she liked to use to teach mathematics.

The legitimisation of certain activities that I like to use in my maths has been the major benefit [of EMIC] for me ....
(Beth, Interview 3, p. 2)

Applying Resource Use

During lessons observed in this period, Beth applied the use of a number of resources specifically referred to during EMIC sessions. For example children’s literature and calculators (see Vignette 7.16).

During Interview 3 conducted in this period, Beth reflected on her new knowledge of how to use resources.

I was using MCTP previous to EMIC ... but ... they told you what you can do [how to adapt the ideas]. (Beth, Interview 3, p. 1)

She also acknowledged the personal benefit she saw in her new knowledge and understandings with respect to resource use.

[A] major benefit for me was [the] resources.
(Beth, Interview 3, p. 2)

Applying and reflecting on Assessment Strategies

During this period Beth consolidated her use of some alternative assessment strategies. In particular, during Observations 7 and 8, she made use of observation and questioning (see Vignettes 7.15 & 7.16). However, it appeared from comments made
during Interview 3, that Beth lacked confidence with respect to her assessment practices, and that she would like more information in this area.

I find that sometimes how I do my maths and how I assess it is not right. ... Sometimes I don’t feel they [tests] reflect what we’ve done ... but I don’t know how you do that. (Beth, Interview 3, p. 4)

I really like the idea [of student journals] but I’m just not sure how I would use it ... I need further information on that. (Beth, Interview 3, p. 5)

Overview of changes in Beth’s Classroom Practice

Table 7.2 displays an overview of the strategies and resources explored by Beth (these include both strategies and resources that were new to her mathematics teaching, and familiar strategies and resources that she used in new ways), and an overview of her changed knowledge and beliefs (including new knowledge and beliefs and the consolidation of some existing beliefs).

Beth explored several strategies and resources that were presented during the EMIC program (see Table 7.2). She developed some new knowledge and beliefs, and she applied some strategies and resources as part of her regular mathematics teaching practice. The changes in Beth’s practice that were enduring and therefore represent growth are described in the next section.
Table 7.2
Beth's Classroom Practice: Overview of Strategies and Resources Explored and Changed Knowledge and Beliefs

<table>
<thead>
<tr>
<th>CLASSROOM PRACTICE COMPONENT</th>
<th>STRATEGIES AND RESOURCES EXPLORED</th>
<th>CHANGED KNOWLEDGE AND BELIEFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEACHING STRATEGIES</td>
<td><em>Student groupings</em></td>
<td>- awareness of new ways of using familiar strategies</td>
</tr>
<tr>
<td></td>
<td>- groups</td>
<td>- confirmed belief in the need to use a variety of strategies for teaching mathematics</td>
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<tr>
<td></td>
<td>- pairs</td>
<td>- confirmed belief in the efficacy of strategies explored</td>
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<td></td>
<td><em>Discourse types</em></td>
<td></td>
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<tr>
<td></td>
<td>- discussion</td>
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<td></td>
<td><em>Task types</em></td>
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<tr>
<td></td>
<td>- problem solving/open</td>
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<td></td>
<td>ended tasks</td>
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<td></td>
<td>- games</td>
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<td></td>
<td>- practical tasks</td>
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<td></td>
<td>- projects</td>
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<td></td>
<td><em>Contexts</em></td>
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<td></td>
<td>- theme work</td>
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<td></td>
<td><em>Teachers</em></td>
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<td></td>
<td>- team teaching</td>
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<tr>
<td>RESOURCE USE</td>
<td><em>Commercial publications</em></td>
<td>- awareness of new resources for teaching mathematics</td>
</tr>
<tr>
<td></td>
<td>- miscellaneous teacher books</td>
<td>- awareness of new ways of using familiar resources</td>
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<tr>
<td></td>
<td>- children’s literature</td>
<td>- confirmed belief in the need to use a variety of resources for program planning</td>
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<td></td>
<td><em>School based publications</em></td>
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<td></td>
<td>- problem solving boxes</td>
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<td></td>
<td>- charts</td>
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<td></td>
<td><em>Mathematics teaching and learning</em></td>
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<td></td>
<td>equipment and materials</td>
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<td></td>
<td>- no new equipment explored,</td>
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<tr>
<td></td>
<td>however more equipment used</td>
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<td></td>
<td><em>Technology</em></td>
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<td></td>
<td>- calculators</td>
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<td></td>
<td><em>General materials</em></td>
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<tr>
<td></td>
<td>- boxes/packaging/cartons</td>
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<tr>
<td></td>
<td>- cardboard, string, tape</td>
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<td></td>
<td><em>Human resources</em></td>
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<td></td>
<td>- colleagues</td>
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<tr>
<td></td>
<td>[Note: Beth used an increased number of resources for planning and teaching mathematics]</td>
<td></td>
</tr>
<tr>
<td>ASSESSMENT STRATEGIES</td>
<td><em>Measurement strategies</em></td>
<td>- awareness of new strategies for assessing student learning in mathematics</td>
</tr>
<tr>
<td></td>
<td>- observation</td>
<td></td>
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<td></td>
<td>- questioning</td>
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<td></td>
<td>- student self-assessment</td>
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<td></td>
<td><em>Recording strategies</em></td>
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<tr>
<td></td>
<td>- anecdotal records</td>
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</tbody>
</table>

7.3.3 Beth's professional growth

This section describes key aspects of Beth's professional growth with respect to each component of Classroom Practice, and the growth networks associated with that growth. Figure 7.6 displays an overview of Beth's growth networks with respect to each Classroom Practice component. Each of these components is discussed below.
Growth with respect to Teaching Strategies

Beth's growth with respect to Teaching Strategies appeared to have been stimulated by her enaction in her classroom of the ideas presented during EMIC sessions, and her continuous reflection on her experimentation. Beth explored several teaching strategies, and she reflected on the practicalities of her explorations. She also reflected on the effects of certain classroom behaviours associated with her experimentation. Beth's reflection on the strategies she explored led her to incorporate several strategies into her ongoing mathematics teaching practice. Key aspects of Beth's growth with respect to Teaching Strategies included:

- an extended repertoire of teaching strategies;
- confirmed belief in the need to use a variety of strategies for teaching mathematics;
  and
- confirmed belief in the efficacy of teaching strategies explored.

Growth with respect to Resource Use

Beth was particularly enthusiastic about her new knowledge with respect to Resource Use. Across the time of the study she explored the use of many resources presented during EMIC sessions in her classroom. She also reflected on the nature of her experimentation with respect to Resource Use, and applied some Resource Use strategies in her ongoing teaching practice. It appeared that, like Anne, Beth was primarily concerned with learning about new resources for teaching mathematics, and ways for using them (i.e. the nature of her resource use), rather than the consequences associated with her use of resources. Key aspects of Beth's growth with respect to Resource Use included:

- knowledge of new resources for teaching mathematics;
- knowledge of new ways of using familiar resources for teaching mathematics; and
• an increased use of resources for planning and teaching mathematics.

Growth with respect to Assessment Strategies

Beth's growth in this area was stimulated by her enactment of ideas presented during the EMIC program, her continuous reflection with respect to her exploration of new assessment strategies, and her exploration of new teaching strategies. On several occasions Beth expressed her desire to develop assessment practices that would appropriately reflect the kinds of learning in which students were engaged as she incorporated new teaching strategies into her practice. She applied some new assessment strategies in her practice (including observation and questioning of students), however she identified scope for further growth in this area. Key aspects of Beth's growth with respect to Assessment Strategies included:

• knowledge of new strategies for assessing student learning in mathematics; and
• an extended repertoire of assessment strategies.

There was some evidence that Beth was also beginning to question her beliefs related to the assessment of student learning in mathematics, in particular with respect to the usefulness of tests.

Overall growth network associated with Beth's Classroom Practice

Figure 7.7 displays the overall growth network associated with Anne's growth with respect to Classroom Practice.

![Figure 7.7](image)

*Figure 7.7.* Beth's overall growth network with respect to Classroom Practice.

It appeared that, like Anne, Beth was mostly concerned with the practicalities associated with changing her Classroom Practice (that is, how to implement changes),
rather than the consequences (or outcomes) associated with changing her practice. However she did reflect on the difficulties she experienced with respect to exploring some Teaching Strategies and she persevered with the further exploration of these strategies. She later included these strategies as part of her regular mathematics teaching practice.

*Other aspects of growth*

Beth also demonstrated and reported some growth with respect to certain general aspects of her mathematics teaching. During Interviews 2 and 3, she reported that she had developed confidence in her mathematics teaching. Beth attributed her increased confidence to her involvement in EMIC.

> It [participating in EMIC] has affected my teaching. ... It makes you [me] more confident with what you [I] do. (Beth, Interview 3, p. 6)

It seemed however, that while her level of confidence had increased, she did not feel completely at ease about her mathematics teaching.

> I feel still that I'm a bit shaky with my maths [teaching] .... I'm scared to take it a little bit further, to take it where I would be completely happy with what I'm doing. (Beth, Interview 3, p. 2)

Considering that when the study was conducted Beth was relatively new to the profession, and she was in an experimental stage with respect to her mathematics teaching, it is not surprising that she expressed a lack of confidence with teaching mathematics. She appeared aware that she had learnt a lot through participating in EMIC, however she realised that there was more she would like to learn.

Another area of growth for Beth related to her attitude towards her mathematics teaching. During Interview 3, Beth reported increased enjoyment in, and enthusiasm for, mathematics teaching.

> I like to teach like that. It's [EMIC] made me feel better about it [teaching mathematics]. (Beth, Interview 3, p. 2)

> I found it [EMIC] overall of great benefit because it made me more enthusiastic about maths [teaching]. (Beth, Interview 3, p. 7)

Beth's increased enthusiasm for mathematics teaching was demonstrated in her involvement in mathematics activities following the EMIC program. Tanya, the EMIC tutor, reported:

> Beth was just so enthusiastic about anything. From when she went to EMIC I noticed she never missed a maths conference, she never missed anything that was on. So for her it [EMIC] was a great thing. (Tutor Interview, p. 5)
7.3.4 Critical factors associated with Beth’s professional growth

The importance of affirming good practice

It appeared from the analysis of the data collected, that a critical factor in Beth’s professional growth was the fact that the ideas presented in the EMIC program affirmed practices that she had already begun to explore, or that she had considered exploring. During Interviews 2 and 3, Beth reported that at EMIC “there was nothing brand new” presented that she hadn’t heard of before, however she felt encouraged to explore certain strategies that she considered were good. The following interview excerpts illustrate the importance Beth appeared to place on what she referred to as the “legitimisation” of her explorations of particular strategies for teaching mathematics.

I would say it has given me more legitimacy for doing an activity based maths [program]. Because I used it to a certain extent anyway, but I always felt that I shouldn’t be doing it this way because of maybe parent expectations, maybe what the school has, and maybe what people around me had [were doing]. I mean I learnt at college activity based maths is the way to go, and you come into a classroom in a school where it’s not being taught .... But it’s given more legitimacy for that. (Beth, Interview 2, p. 2)

Because other people use them it’s okay to use those kinds of activities .... The legitimisation of certain activities that I like to use in my maths has been the major benefit for me .... (Beth, Interview 3, p. 2)

... a legitimisation that it’s fine to do those things, they have got a place. I like to teach like that. It’s made me feel better about it ... legitimised it. (Beth, Interview 3, p. 2)

It made me feel that what I was doing in some elements it was good to do that. (Beth, Interview 3, p. 7)

An explicit component included in the design of the EMIC program was the valuing of teachers’ current good practice (see Section 3.2.3). The EMIC program seemed to provide the stimulus for Beth’s continued exploration of different strategies for teaching mathematics; being new to the profession and keen to engage in experimentation with a variety of strategies for teaching mathematics, this seemed a critical factor in supporting her professional growth.
7.4 The story of Brian

7.4.1 Brian in context

Teaching background

Brian had nine years teaching experience in primary schools when the study commenced. As a classroom teacher he had taught students in Grade 4 and Grade 5, and he had taught all grade levels in specialist teaching roles including: science, physical education and applied mathematics. Brian had also worked as a relieving teacher.

Brian had been teaching at School B for four years when he became involved in the EMIC program. He was working with a composite Grade 4/5 class at that time. In the second year of the study Brian transferred to a new school for promotion reasons. He taught a composite Grade 5/6 class at that school.

School context

Details of Brian's school context during the first year of the study are the same as those described for Beth (see Section 7.3.1).

During the second year of the study Brian taught at School Z. School Z, which was located in country Victoria (approximately 450 kilometres west of Melbourne), had a student population of 380 and 15 full time teaching staff. The location and student population of School Z provided a distinct contrast for Brian from School B where he had worked the previous year.

Brian described the staff at School Z as enthusiastic. He reported that the mathematics teaching in Grades Prep to 3 was noticeably strong, and he reported that staff members throughout the school were keen to participate in professional development with respect to mathematics. Few staff members at School Z had completed an EMIC course.

Brian's view of his mathematics teaching prior to EMIC

Brian was critical of his mathematics teaching prior to EMIC. He reported a lack of confidence and a lack of knowledge with respect to mathematics teaching and learning ideas.
I'm not coping very well [with my mathematics teaching] I don't think. The only thing that I've got solid to fall on are the basic operations .... It all seems a bit aimless, that's all I've got. (Brian, Interview 1, p. 3)

Most of it is the operations, and I really try to make it like real life maths but I struggle to. (Brian, Interview 1, p. 1)

I think I'm trying too much to do the pure side of it, and not applying this .... I have trouble coming up with examples that are relevant. I find it very, very hard to find stuff that is really challenging .... I just haven't really successfully given them [all students] a challenge. (Brian, Interview 1, p. 5)

Brian described his program as consisting of a variety of number activities. Specifically he referred to tables chanting, tables races, oral counting, operations speed worksheets, and other basic number work.

In the majority of sessions it's mostly work through me. I'm at the front, most of the time we use paper and pencils, some of the time we use materials, and a lot of it's oral, we talk a lot. But it's very much done through me .... It's very teacher directed. (Brian, Interview 1, p. 5)

His mathematics teaching appeared to be traditional in orientation, although he made mention of his exploration of some non-traditional methods—for example, ideas from Reality In Mathematics Education (RIME) 5&6 (Ministry of Education, Victoria, 1989). Brian appeared to value the approaches recommended in resources such as RIME 5 & 6, however he noted some difficulties associated with these approaches.

I've used a couple of ideas from RIME and they've been really good. They've been hard work and messy, but really good. (Brian, Interview 1, p. 3)

Involvement in EMIC

Brian's apparent dissatisfaction with his mathematics teaching provided motivation for his participation in EMIC. He reported that he felt that EMIC would provide him with the ideas and training he needed to improve his teaching.

I think it's what I really need. It's been a long time since I've had any new ideas in maths. (Brian, Interview 1, p. 1)

There's a lot of good ideas [currently available in mathematics education], but I struggle to implement them through lack of training. I think EMIC will make a good difference, a good difference. (Brian, Interview 1, p. 9)
He also reported that his students’ attitudes towards mathematics provided impetus for his involvement in EMIC.

I feel that most of the maths, too many kids don’t enjoy it .... I found out that some kids really don’t like maths, they hate maths. And that was sufficient for me to want to do something about it. I’m sure they like some parts of it but maybe that’s not enough. ... Maybe through doing EMIC that will become less of a problem.

(Brian, Interview 1, p. 1)

Brian appeared to regard his involvement in EMIC as necessary for the improvement of his teaching.

7.4.2 Brian’s Classroom Practice

Vignettes and change sequences

Vignettes 7.17–7.21 provide outlines of the lessons observed in Brian’s classroom to set the context for the discussion which follows. Due to logistical constraints associated with distance, it was only possible to observe one lesson in Brian’s classroom at School Z. This meant that Brian was observed twice during the EMIC program, twice soon after the EMIC program, and once in the period 10–12 months after the EMIC program.

Vignettes 7.17, 7.18, 7.19, 7.20, and 7.21

Vignettes of Lessons Observed: Brian

<table>
<thead>
<tr>
<th>VIGNETTE 7.17 (Source: Observation 1, May, Grade 4/5)</th>
<th>VIGNETTE 7.18 (Source: Observation 2, August, Grade 4/5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>To begin this lesson Brian conducted a discussion with the whole class that reviewed ideas explored in the previous session with respect to estimating and calculating the number of text in a newspaper. Brian asked students to report the strategies they had used referring to the work samples they had previously completed. He then presented a story shell related to the print run of a newspaper and he posed some further investigations related to the story shell context. The students worked on these investigations in groups using calculators. Brian observed them as they worked and he asked questions of groups when he considered it appropriate. To conclude the lesson Brian discussed with the students different strategies used in the investigations.</td>
<td>Brian presented an introductory problem solving task that involved students working in pairs to determine how many squares they could draw on a grid of dots. He then conducted a whole class discussion related to the strategies the students used. Next Brian demonstrated a calculator game called &quot;Squares&quot;. The students then worked in pairs to play the game. After several minutes Brian altered the number range, demonstrated the effect of that change, and asked the students to select a different range and play again. Brian then demonstrated another calculator game (&quot;Mystery Divisor&quot;) and he challenged the class to play the game against him.</td>
</tr>
</tbody>
</table>
Soon After the EMIC Program

<table>
<thead>
<tr>
<th>VIGNETTE 7.19</th>
<th>VIGNETTE 7.20</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: Observation 3, October, Grade 4/5)</td>
<td>(Source: Observation 4, November, Grade 4/5)</td>
</tr>
<tr>
<td>During this lesson Brian and one of the other teachers involved in this study, Beth, combined their classes and taught together. Brian and Beth planned and prepared four different tasks related to fractions. This was the second lesson in a sequence of lessons to complete these tasks. They introduced the lesson by reviewing the tasks and the procedure for the students to work on them. The students worked in groups on one task for 15 minutes then moved to a second task. Brian and Beth observed the groups as they worked and asked questions when they considered it appropriate. Towards the end of the session Brian and Beth asked one group to report on their work on the tasks, focusing on processes and solutions.</td>
<td>In this lesson Brian organised the students into cooperative groups to work on a number of investigations which required the collection of data. He explained the procedure for the lesson modelling mathematical language related to the tasks (e.g. frequency), then the students collected resources needed and commenced their investigations. The students worked in their groups for the remainder of the session. Brian moved around to observe each group as they worked, and to ask questions of them when he considered it appropriate.</td>
</tr>
</tbody>
</table>

10–12 Months After the EMIC Program

<table>
<thead>
<tr>
<th>VIGNETTE 7.21</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: Observation 5, June, Grade 5/6)</td>
</tr>
<tr>
<td>To begin this lesson Brian explained a number of tasks which required the use of the four operations, using the blackboard to demonstrate his ideas. He then organised the students into small groups to work on one of four tasks he had prepared. These were: calculations using MAB materials; board games; a mathematical puzzle; and an exploration of the operations using MAB materials. Three groups worked independently and the group nominated to participate in exploring the operations worked with Brian. Brian asked the students in that group to nominate a specific operation on which they wanted to work. The group chose &quot;trading&quot; with respect to subtraction. Brian encouraged the students in each group to assist one another when help was needed. It was planned that in the following three lessons the groups would rotate so that each group would work with Brian during that week.</td>
</tr>
</tbody>
</table>

Figure 7.8 displays an overview of the change sequences associated with Brian's professional growth in the different study time periods. Each of these periods is discussed below.
During the EMIC Program

The data collected provided evidence that during this period Brian engaged in classroom experimentation with Teaching Strategies and Assessment Strategies that were presented in EMIC sessions. He also reflected on his exploration of Assessment Strategies.

Exploring Teaching Strategies

During Observation 1 (see Vignette 7.17), Brian involved his students in some problem solving tasks focused on number. Brian used a strategy that had been presented during an EMIC session, a “story shell”, to create a context for the tasks (the story shell related to printing a newspaper). Brian encouraged his students to discuss the calculation strategies they used as they participated in the tasks. The “discussion” of students’ mathematics strategies was emphasised by Tanya, the EMIC tutor, during the EMIC sessions, and it was emphasised in the EMIC program documentation (see Ministry of Education, 1990a). Brian also encouraged students to discuss their problem solving strategies during Observation 2 (see Vignette 7.18).

Exploring and reflecting on Assessment Strategies

Comments Brian made during Interview 1 indicated that he was beginning to reconsider his assessment practices. He reported that previously he had used testing as the main strategy for assessing student performance, however recently he was emphasising observation of students and questioning.

I used to test them, I used to give them an end of unit test, but I’ve stopped doing that. Now what I say to them is: “okay, I’m going to give you four of these problems, and when you’ve done them you can go on with some other work”. And those problems usually are enough to gauge it. (Brian, Interview 1, pp. 7-8)

I want to see how confident they are in approaching something. Some kids are really no good under pressure, and it’s important to find out what they know outside the pressure. (Brian, Interview 1, p. 8)

I think you can find out a lot from the questions kids ask too. (Brian, Interview 1, p. 2)

During the lessons observed in his classroom in this period Brian observed students as they worked, and questioned them about the problem solving and calculation strategies they were using and the solutions they achieved (see Vignettes 7.17 & 7.18). These assessment strategies were emphasised in the EMIC program.
A note related to Resource Use

During Interview 1 Brian spoke of a range of resources that he regularly used for teaching mathematics. During lessons observed in this period, he used three different resource types: commercial publications (lesson ideas and photocopied worksheets); mathematics teaching and learning materials (MAB); and technology (calculators). There is no conclusive evidence in the available data from this period to suggest that Brian’s reference to, or use of, resources at this time was directly linked to his participation in EMIC. However, it is likely that the emphasis given in the EMIC program to the commercial publication Reality In Mathematics Education (RIME) 5&6 (Ministry of Education, Victoria, 1989), acted as a stimulus for his use of this resource to plan the lesson described in Vignette 7.17.

Soon After the EMIC Program

The data collected provided evidence that Brian engaged in much reflection during the period soon after the EMIC program. Brian reflected on the classroom practicalities of the new ideas he was exploring with respect to each component of Classroom Practice. He reflected on the content of the EMIC program with respect to Teaching Strategies and applied some new knowledge in this area to his ongoing practice. Brian also interpreted some classroom behaviours associated with his use of Teaching Strategies as salient outcomes. Further, it appeared that Brian began to apply some new Resource Use ideas to his ongoing classroom practice.

Reflecting on and applying Teaching Strategies

During Observations 3 and 4 (see Vignettes 7.19 & 7.20), Brian explored a strategy that was new to his mathematics teaching, cooperative group learning. When he discussed this strategy during Interview 2, he reported that while he was familiar with cooperative group work he had not previously used it for teaching mathematics.

In maths last year I didn’t group them [students]. So the change has been not that cooperative learning is new to my teaching, but it is in my maths teaching. (Brian, Interview 2, p. 3)

During Interview 2 Brian spoke enthusiastically of his application of cooperative groups as a regular part of his practice, and he attributed his new knowledge of this strategy (as it applies to the teaching of mathematics) to the EMIC program.

Maths was pretty much a quiet time—do your own work, put up your hand if you’ve got a problem and I’ll come and see you. Now I’ve got the kids working in groups and tutoring other kids and, well
cooperative learning. I just didn't think it was for maths. But it is and EMIC showed me that. It really is excellent for maths. (Brian, Interview 2, p. 3)

As Brian spoke of his changed practice with respect to teaching strategies he stated that he and his students were enjoying mathematics lessons more.

I've changed enormously there [with respect to Teaching Strategies], and I'm so much happier for it. I think the kids are happier [too]. (Brian, Interview 2, p. 3)

Exploring, reflecting on and applying Resource Use

During Interview 2 Brian made few comments with respect to Resource Use. He reflected on his exploration with a new resource—playing cards. He stated that he thought his use of cards was associated with the ideas presented at EMIC.

I've got right into cards and I think it's because of EMIC. I don't remember anyone at EMIC saying go for it, but it's part of the philosophy or the mentality that maths is fun and it's not just figures. (Brian, Interview 2, p. 4)

Brian's emphasis on maths being "fun" is discussed further in Section 7.4.3.

During Interview 2 Brian also reported that he was applying the use of calculators more often than he had previously.

I'm using calculators more often. (Brian, Interview 2, p. 3)

Exploring and reflecting on Assessment Strategies

During Observation 3 (see Vignette 7.19), Brian explored a new assessment strategy—student self assessment. While team teaching with Beth, Brian asked student groups to assess their own performance, focusing on the processes they used to complete set tasks related to fractions, and their solutions. Brian also continued to explore observation and questioning of students in both of the lessons observed in this period.

During Interview 2, Brian expressed his desire to develop assessment practices that would appropriately reflect the kinds of learning in which students were engaged as he incorporated new teaching strategies into his practice.

My teaching is so far away from what it was that my old checklists are not really relevant to what I'm doing. (Brian, Interview 2, p. 5)

Brian identified a number of issues associated with his exploration of new assessment and teaching strategies. The following interview excerpt highlights the difficulties associated with changing one's practice.
And now a lot of our work is not formally recorded and so I'm using different criteria to judge them [students]. So I guess a lot of it must be more almost, anecdotal and less right and wrong by what's on paper. When I speak to the parents, I feel a bit vulnerable here because I've got this suspicion that I'm a bit airy fairy now. It was easier in the past when I was more algorithm-centred for want of a better description. ... It was really easy to record those things.
(Brian, Interview 2, p. 5)

Ten to Twelve Months After the EMIC Program

During the period 10–12 months after the EMIC program Brian continued to engage in reflection, and he consolidated his changed practice with respect to each component of Classroom Practice.

Applying and reflecting on Teaching Strategies

During Interview 3, Brian made several comments that indicated he was applying some of the new teaching strategies that were presented during EMIC to his ongoing mathematics teaching practice.

Something that struck me when I heard it at EMIC, and I thought oh I don't do that, that I do now, is calling for ... multiple approaches, multiple strategies [from students] .... (Brian, Interview 3, p. 3)

I might have been a little inclined to do that [physical activities] a bit anyway before EMIC, but I'm more inclined to now.
(Brian, Interview 3, p. 4)

During this interview, Brian also reflected on the consequences associated with his application of group work in mathematics.

I'm really happy working with groups in maths.
(Brian, Interview 3, p. 3)

Applying and reflecting on Resource Use

Brian applied many resource use ideas during this period and he reflected on his use of different resources. During Interview 3, he spoke enthusiastically of specific references that were presented during EMIC sessions that he was now regularly using.

I just got my toes in the water with that MCTP and RIME [resource books referred to during EMIC sessions]. I don't know if I did that just before or during EMIC. But I've been through the RIME things. I love those, they're great. (Brian, Interview 3, p. 4)

Every couple of weeks I look through the [EMIC] folder. ... [I use] things I got in my EMIC course, activities from there.
(Brian, Interview 3, p. 4)
Brian also spoke enthusiastically about his role as mathematics coordinator at his new school, and in particular about being responsible for purchasing new mathematics resources for the school.

*Applying and reflecting on Assessment Strategies*

Brian's comments during Interview 3 indicated that he considered his assessment practices had changed significantly. He appeared to have consolidated his changed beliefs with respect to assessing student performance, and he reported increased confidence in his assessment practices.

> Content, that's part of my report, but also attitude. Whether this child will have a go, and how this child will approach problems. ... I'm looking for those sorts of things more. (Brian, Interview 3, p. 5)

It [realising the importance of attitudes] has certainly affected my assessment. I've changed what I'm looking for, or the emphasis on what I'm looking for. (Brian, Interview 3, p. 5)

I've got so much more confidence [with respect to assessment] than I had. (Brian, Interview 3, p. 5)

*Overview of changes in Brian's Classroom Practice*

Table 7.3 displays an overview of the strategies and resources explored by Brian (these include both strategies and resources that were new to his mathematics teaching, and familiar strategies and resources that he used in new ways), and an overview of his changed knowledge and beliefs (in particular, new knowledge and beliefs).
### Table 7.3

**Brian’s Classroom Practice: Overview of Strategies and Resources Explored and Changed Knowledge and Beliefs**

<table>
<thead>
<tr>
<th>CLASSROOM PRACTICE COMPONENT</th>
<th>STRATEGIES AND RESOURCES EXPLORED</th>
<th>CHANGED KNOWLEDGE AND BELIEFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEACHING STRATEGIES</td>
<td><em>Student groupings</em></td>
<td>- awareness of new strategies for teaching mathematics</td>
</tr>
<tr>
<td></td>
<td>- groups</td>
<td>- awareness of the efficacy of teaching strategies explored</td>
</tr>
<tr>
<td></td>
<td>- pairs</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Discourse types</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- discussion</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Task types</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- problem solving tasks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- games</td>
<td></td>
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<td></td>
<td>- practical tasks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- physical activities</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Contexts</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- story shells</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Teachers</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- team teaching</td>
<td></td>
</tr>
</tbody>
</table>

| RESOURCE USE                | *Commercial publications*         | - awareness of new resources for teaching mathematics |
|                             |   - MCTP, RIME 5 & 6              | - awareness of new ways of using familiar resources |
|                             |   - miscellaneous teacher books   | - awareness of the efficacy of resources explored |
|                             | *School based publications*       |                              |
|                             |   - no new school based publications explored |                              |
|                             | *Mathematics teaching and learning equipment and materials* |                              |
|                             |   - no new equipment explored     |                              |
|                             | *Technology*                      |                              |
|                             |   - calculators                   |                              |
|                             | *General materials*               |                              |
|                             |   - playing cards                 |                              |
|                             |   - cardboard, string, tape       |                              |
|                             | *Human resources*                 |                              |
|                             |   - colleagues                    |                              |

| ASSESSMENT STRATEGIES       | *Measurement strategies*          | - awareness of new strategies for assessing student learning in mathematics |
|                             |   - observation                   | - awareness of the efficacy of assessment strategies explored |
|                             |   - questioning                   |                              |
|                             |   - student self-assessment       |                              |
|                             | *Recording strategies*            |                              |
|                             |   - anecdotal records             |                              |
|                             |   - checklists                    |                              |

Brian explored a number of strategies and ideas that were presented during the EMIC program (see Table 7.3). His explorations and his reflection on his changed practice led him to develop some new knowledge and beliefs. In addition he applied some strategies and ideas as part of his regular mathematics teaching practice. The changes in Brian’s practice that were enduring and therefore represent growth are described in the next section.
7.4.3 Brian's professional growth

This section describes key aspects of Brian's professional growth with respect to each component of Classroom Practice, and the growth networks associated with that growth. Figure 7.9 displays an overview of Brian's growth networks with respect to each Classroom Practice component. Each of these components is discussed below.

<table>
<thead>
<tr>
<th>TEACHING STRATEGIES</th>
<th>RESOURCE USE</th>
<th>ASSESSMENT STRATEGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXT</td>
<td>EXT</td>
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<tr>
<td>PERS</td>
<td>PERS</td>
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<td>PRAC</td>
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<td>CONS</td>
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Figure 7.9. Brian's growth networks: Classroom Practice.

Growth with respect to Teaching Strategies

Brian's growth with respect to Teaching Strategies appeared to have been stimulated by his enactment in his classroom of the ideas presented during EMIC sessions, his reflection on his experimentation and his reflection on the content of the EMIC program. Brian explored several new teaching strategies and reflected on the practicalities and consequences associated with his experimentation. This led him to incorporate several new strategies into his ongoing mathematics teaching practice. Key aspects of Brian's growth with respect to Teaching Strategies included:

- knowledge of new strategies for teaching mathematics;
- an extended repertoire of teaching strategies; and
- new beliefs related to the efficacy of teaching strategies explored.

Growth with respect to Resource Use

Brian explored the use of several resources presented during EMIC sessions in his classroom. He also reflected on the nature of his experimentation with respect to Resource Use, and applied some Resource Use strategies in his ongoing teaching practice. Further, it appeared that Brian interpreted some classroom behaviours associated with his experimentation with resources as positive salient outcomes. Key aspects of Brian's growth with respect to Resource Use included:
• knowledge of new resources for teaching mathematics;
• knowledge of new ways of using familiar resources for teaching mathematics; and
• new beliefs related to the efficacy of resources explored.

**Growth with respect to Assessment Strategies**

Brian’s growth in this area was stimulated by his enaction of ideas presented during the EMIC program, his continuous reflection on his exploration of new assessment strategies and his reflection on the content of the EMIC program. In addition, it appeared that Brian’s exploration of new teaching strategies affected his growth in this area. Like Beth, Brian expressed his desire to develop assessment practices that would appropriately reflect the kinds of learning in which students were engaged as he incorporated new teaching strategies into his practice. Brian also expressed new beliefs with respect to the efficacy of assessment strategies explored. Key aspects of Brian’s growth with respect to Assessment Strategies included:

• knowledge of new strategies for assessing student learning in mathematics;
• an extended repertoire of assessment strategies;
• new beliefs related to the efficacy of assessment strategies explored; and
• new beliefs related to the assessment of student learning in mathematics.

**Overall growth network associated with Brian’s Classroom Practice**

Figure 7.10 displays the overall growth network associated with Brian’s growth with respect to Classroom Practice.

![Diagram](image)

*Figure 7.10. Brian's overall growth network with respect to Classroom Practice.*

Like Anne and Beth, Brian appeared to be mostly concerned with the practicalities associated with changing his Classroom Practice (that is, how to implement changes).
However with respect to Teaching Strategies and Resource Use he also considered the consequences (or outcomes) associated with changing his practice.

Other aspects of growth

Across the time of the study Brian demonstrated and reported some growth with respect to certain general aspects of his mathematics teaching. In particular, he demonstrated increased confidence, and a change in attitude towards the teaching of mathematics.

Brian appeared confident in each of the lessons observed in his classroom. However comments he made during interviews revealed that he did not feel comfortable with his mathematics teaching early in the study.

I’m not coping very well [with teaching mathematics] I don’t think. (Brian, Interview 1, p. 3)

I was really worried about [teaching] maths before I did EMIC. (Brian, Interview 3, p. 2)

I was really under-confident in maths. (Brian, Interview 3, p. 3)

Brian reported that through his participation in EMIC, he felt he had developed more confidence to try different strategies and ideas, and he reported greater confidence in the approaches he was using.

I’ve got so much more confidence than I had. (Brian, Interview 3, p. 5)

I feel so much better. And, I know I’ve got to make some ground yet, but I think I’m on the right track now. I was lost before it [EMIC]. (Brian, Interview 3, p. 8)

However, like Beth, Brian tended to temper positive comments about perceived improvements in his teaching. For example:

I’m reasonably comfortable with the way I’m tackling maths as a result of the EMIC program, but I’ll bet my bottom dollar that there are other and better ways. (Brian, Interview 3, p. 1)

Another area of growth for Brian related to his attitude towards mathematics teaching. During Interview 3 Brian reported that his involvement in the EMIC program “invigorated” him (Brian, Interview 3, p. 7).

It changed my whole outlook ... to maths. ... It had a really big impact on me. All positive. ... It’s changed me. It’s changed my attitude. (Brian, Interview 3, p. 8)
Specifically, Brian appeared to enjoy his mathematics teaching more, and he seemed more positive about it. Comments such as: "I'm really happy", "I love those activities], they're great", and "I feel so much better" (Brian, Interview 3, pp. 3, 4 and 8 respectively) reflected this increased enjoyment and enthusiasm.

It appeared that Brian also wanted his students to enjoy mathematics more. Throughout Interview 3 Brian made frequent reference to mathematics lessons being “fun” for students. While this was a characteristic of lessons that was promoted in a positive way in the EMIC program, it appeared that Brian had an almost exaggerated sense of the importance of lessons being “fun”.

7.4.4 Critical factors associated with Brian's professional growth

The importance of motivation

It appeared that a critical factor associated with Brian's professional growth was his enthusiastic attitude towards improving his teaching. Brian openly reported his need for inserviceing with respect to mathematics. Prior to EMIC he had not participated in any professional development related to mathematics for a long time.

I think it's [EMIC] what I really need. (Brian, Interview 1, p. 1)

I feel like I'm starving here for new ideas.
(Brian, Interview 1, p. 4)

Across the time of the study, Brian demonstrated a keen interest in all that was presented in EMIC. He actively participated in EMIC sessions, completing most of the classroom explorations and between session reading tasks that were included in the program. Brian also engaged in continual reflection on his mathematics teaching. This included reflection with respect to those activities directly associated with the EMIC program, and other activities that he explored. Reflection on his teaching appeared to be a regular part of Brian's mathematics teaching practice. Tanya, the EMIC tutor, described Brian as an enthusiastic teacher.

I've known Brian for years and years, and he was always quite an enthusiastic person about anything that was going. He was a "keeper-upper". He kept up with everything.
(Tutor Interview, p. 5)

A further way in which Brian demonstrated his keen motivation to improve his teaching was in his contact with other teachers. Brian contacted and visited other teachers to follow up ideas that interested him.
The importance of the school environment

A factor that appeared critical with respect to Brian’s professional growth was his association with other staff from School B who were participating in EMIC. Seven staff members from School B were involved in the EMIC course investigated in this study. Brian appeared to value the support staff members provided for one another, and the sense of collegiality that developed through their shared interest in the program.

During Interview 2 Brian reported that the staff at School B engaged in regular conversations about EMIC.

It’s been excellent to have a number of us from the one place going. That’s been a big plus. EMIC really dominated some of the conversations. (Brian, Interview 2, p. 5)

He also noted how motivated the staff were towards using ideas from the program.

People from the school [School B] who went and did EMIC were all very, very motivated by it and very positive towards it. And different ones have said to me “maths is really fun now, the kids are really enjoying it, and so am I”. And it’s just wonderful, really enthusiastic, sort of from the heart speech. And I think that’s the way it’s been throughout the school. (Brian, Interview 2, p. 5)

During an informal discussion with Brian and Beth following an observation of a lesson where they taught their classes together (see Vignette 7.19), Brian mentioned how much he had enjoyed planning lessons with Beth. He referred to a new enthusiasm demonstrated by staff with respect to mathematics, in particular during informal conversations that occurred in the staff room. Brian reported that staff who had attended EMIC were sharing ideas and resources regularly (Brian, Fieldnotes, Observation 3).

Brian spoke further of the staff’s increased talk with respect to mathematics teaching during Interview 3. He considered that the involvement of so many staff had a strong and positive impact on the teaching of mathematics at School B.

It really did have an effect on the school I think. We talked maths more, instead of being defensive about it .... Because we thought well we’re not very innovative, we’re not very exciting, maths is hard to get them turned on. We were talking maths more, saying isn’t that a great activity. ... And maths was talked over the morning tea table. And teachers are more confident and positive. It [EMIC] had a very big effect. Very. (Brian, Interview 3, p. 6)

Brian acknowledged that at School B “it was a big change in a small school”, and he inferred that such change was possible because “lots of us [staff] did it” (Brian,
Interview 3, p. 6). Brian was so convinced of the impact that the involvement of several staff members had at School B, that he stated he would like all of the staff at his new school (School Z) to participate in an EMIC course together.

7.5 The story of Cath

7.5.1 Cath in context

Teaching background

When the study commenced Cath had 17 years teaching experience. As a generalist classroom teacher she had taught all primary grade levels from Prep to Grade 6. As a curriculum specialist, she had taught computer education studies from Prep to Grade 8, and mathematics in Grades 7 and 8.

Cath had been teaching at School C for five and a half years when she became involved in the EMIC program. She was working with a composite Grade 4/5 class at that time. In the second year of the study Cath taught a composite Grade 5/6 class at the same school.

School context

School C, which was located in an inner suburb of Melbourne, had a student population of 320 and 12 full time teaching staff.

Two teachers from School C participated in the EMIC course investigated in this study. Three others had been involved in an EMIC course conducted earlier in the same school region.

Mathematics as a curriculum area did not appear to have a high profile in School C. Across the time of the study no specific events associated with mathematics were observed at the school. During Interview 1, Cath noted that there was no real leadership in the mathematics area evident in the school. She further reported an apparent lack of interest or support from the maths coordinator with respect to participating in EMIC.

Unless you have got somebody who has a real passion for that subject and really pushes it forward in front of everybody all of the time and keeps it going ... then I think it’s difficult. I did mention to the maths coordinator that I thought EMIC would be fantastic and the comment was “I don’t have time for that, I’m only interested in the
grade". So that's fairly hard when you don't have that support.
(Cath, Interview 1, p. 9)

Cath's view of her mathematics teaching prior to EMIC

Cath was very positive and confident about her own abilities in mathematics, and her mathematics teaching prior to EMIC.

I really like teaching maths. I'm fairly confident with maths myself .... (Cath, Interview 1, p. 1)

I just always liked and enjoyed maths. I'm good at maths.
(Cath, Interview 1, p. 2)

I've always felt that I am an effective maths teacher. ... I feel that when children leave I've done a fairly good job [teaching maths].
(Cath, Interview 1, p. 3)

The description Cath provided of her mathematics teaching during Interview 1, indicated that her approach combined traditional and non-traditional strategies. Cath reported that she based her mathematics teaching on the commercial program Rigby (Iron & Scales, 1984), but complemented the Rigby approach with the use of ideas from other references. She referred to "formal sessions" which she implied covered basic concepts and skills, and in addition she spoke of the importance of making learning tasks practical and relevant to students, and of involving students in group tasks.

I've always believed, even before EMIC, that maths must be practical in a way that children can see that there is a reason to use it in everyday life. (Cath, Interview 1, p. 3)

I try to get a balance between more formal work and group work. I try to do an activity, perhaps a more practical activity where they're working together a bit more and having fun, but at the same time I am aware that there are basic things that children need to know.
(Cath, Interview 1, p. 5)

Involvement in EMIC

During Interview 1 comments Cath made with respect to her motivation for participating in EMIC suggested that she was committed to ongoing learning and to the continued improvement of her mathematics teaching.

I'm always wanting new ideas or [to] make things a bit more interesting and a bit more inspiration for myself as well.
(Cath, Interview 1, p. 1)

I'm sure that I could improve [my maths teaching] or I wouldn't be doing the course if I didn't think there are some areas.
(Cath, Interview 1, p. 3)
Cath reported that she hadn’t been involved in a lot of inservice related to mathematics, and that she felt “it would add to the maths program that I [she] was already doing” (Cath, Interview 1, p. 1). Cath was seeking “inspiration” and “ideas” from her participation in EMIC.

### 7.5.2 Cath’s Classroom Practice

**Vignettes and change sequences**

Vignettes 7.22–7.28 provide outlines of the lessons observed in Cath’s classroom to set the context for the discussion which follows. During the period 10–12 months after the EMIC program, Cath was relieved from classroom teaching responsibilities to perform the role of Acting Deputy Principal at School C. This meant that only one observation could be conducted in Cath’s classroom in this period.

Vignettes 7.22, 7.23, 7.24, 7.25, 7.26, 7.27, and 7.28

Vignettes of Lessons Observed: Cath

<table>
<thead>
<tr>
<th><strong>During the EMIC Program</strong></th>
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<tr>
<td><strong>VIGNETTE 7.22</strong></td>
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<tr>
<td><em>(Source: Observation 1, June, Grade 4/5)</em></td>
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Cath introduced this lesson by posing a problem solving task that had been presented during an EMIC session. The task involved the construction of a freestanding tower using newspaper and masking tape. Cath organised the students into cooperative groups to work on the task. She described the roles of different group members and then the groups commenced work on the task. Cath moved around the room encouraging groups, observing and questioning them, and taking photos as they worked. To conclude the session Cath asked the groups to display their constructions and to report the strategies they used. She then asked them to make an assessment of their group’s work.

In this lesson Cath adapted an idea presented by Tanya during an EMIC session. The idea called “The Giant’s Foot” by Tanya was retitled by Cath as “The Alien’s Foot”. Cath introduced the lesson by discussing with the students what they knew about the proportions of body parts. She asked them to estimate the comparative sizes of different body parts. She then created a story shell about aliens and she presented a drawing of an alien’s foot. Cath then challenged the students to work in pairs to determine the likely measurements of the alien’s body parts. The students estimated the size of the alien’s body parts and drew scale drawings of the alien. Cath observed them as they worked, questioning them when she considered it appropriate. The groups presented their results and reported on the processes they used to complete the task.
### Soon After the EMIC Program

<table>
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<tr>
<th>VIGNETTE 7.24</th>
<th>VIGNETTE 7.25</th>
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<tr>
<td>(Source: Observation 3, October, Grade 4/5)</td>
<td>(Source: Observation 4, December, Grade 4/5)</td>
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<td>To begin this lesson Cath involved the whole class in a discussion related to a shopping theme. They talked about packaging and newspapers and then Cath asked the students to investigate the number of trees used to print a single edition of a newspaper. Cath discussed with the students some possible strategies that could be used then the students worked in pairs on the task. They made use of newspapers, scales and calculators. Towards the end of the lesson several students reported on their progress with the task. Cath planned for the students to continue the task in the following lesson.</td>
<td>Cath involved the students in a whole class discussion related to buying gifts at Christmas. She posed a hypothetical situation where the students were asked to work in pairs and use 5 catalogues to select 20 gifts that a family of 4 would enjoy receiving. The students were asked to cut out the gifts, to list the prices, and to display them on a large sack. The students collected the materials they needed and worked on the task for the remainder of the lesson. As the students did not complete the task in the session Cath stated that they would continue to work on it the following day.</td>
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<tr>
<th>VIGNETTE 7.26</th>
<th>VIGNETTE 7.27</th>
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<tr>
<td>(Source: Observation 5, March, Grade 5/6)</td>
<td>(Source: Observation 6, April, Grade 5/6)</td>
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<td>Cath began this lesson with a class discussion related to average. She asked the students what they knew about average and how they might define the term. Cath listed examples provided by the students of how the term is used. She then asked the students to work in groups to determine the average size and mass of some food items (peas and potatoes). Following the students’ investigations, the groups reported their findings. Cath discussed with the students the purpose of the activity and what they had learned about determining averages.</td>
<td>This session began with a whole class discussion related to the song Waltzing Matilda. The terms in the song, and the storyline were the focus of the discussion. Following the discussion students sang different verses and the class sang the chorus. Cath then explained a task related to mapping and location that was linked to the song. The students were asked to work in pairs to draw objects referred to in the song in particular positions. The students worked on the task for the remainder of the lesson.</td>
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### 10–12 Months After the EMIC Program

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<th>VIGNETTE 7.28</th>
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<tr>
<td>(Source: Observation 7, June, Grade 5/6)</td>
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<td>This lesson was one in a series related to a unit of work on the theme “Olympic Games”. The students worked in groups to create a plan for a family of four travelling to the Olympic Games. Their plans had to include estimated costs, itineraries, events to attend etc. The students worked in small groups on the task. Towards the end of the lesson Cath asked each group to report on their progress including strategies they were using, and any difficulties they were experiencing.</td>
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Figure 7.11 displays an overview of the change sequences associated with Cath’s professional growth in the different study time periods. Each of these periods is discussed below.
**Figure 7.11.** Cath’s change sequences: Classroom Practice.

**During the EMIC Program**

The data provided evidence that this was a period of exploration for Cath with respect to the different components of Classroom Practice. Cath engaged in classroom experimentation with Teaching Strategies, Resource Use and Assessment Strategies ideas, that were presented in EMIC sessions.

**Exploring Teaching Strategies**

During Observations 1 and 2 (see Vignettes 7.22 & 7.23), Cath explored several teaching strategies that had been presented during EMIC sessions. Strategies that she explored that were new to her mathematics teaching included: student reporting (discourse types); and story shells and theme work (contexts). Cath also encouraged her students to discuss the problem solving and estimation strategies they used as they participated in the tasks during these lessons. The “discussion” of students’ mathematics strategies was emphasised by Tanya, the EMIC tutor, during the EMIC sessions, and it was emphasised in the EMIC program documentation (see Ministry of Education, 1990a). While this teaching strategy was not “new” to Cath, it appeared that the emphasis placed on discussion in the EMIC program acted as a stimulus for her use of this strategy in mathematics lessons at this time.

**Exploring Resource Use**

During Interview 1 Cath reported that she used a variety of resources to teach mathematics. She referred to her use of different resources for planning mathematics lessons, and she mentioned a range of mathematics equipment and materials that she regularly used. During Observations 1 and 2 (see Vignettes 7.22 & 7.23), Cath
explored the use of a several general materials including string, tape, newspapers and cardboard pieces. The use of these kinds of “everyday” materials was emphasised by Tanya during EMIC sessions. During an interview conducted in a later period of this study, Cath reported that the use of these kinds of general materials was new to her mathematics teaching practice.

Exploring Assessment Strategies

During lessons observed in Cath’s classroom in this period, she made use of several assessment strategies that were emphasised in the EMIC program. These included observation, questioning of students, and student self-assessment. Comments Cath made during an interview conducted in a later period of the study revealed that while these strategies were not new to her, she considered that her use of them during this period was stimulated by her involvement in EMIC at this time.

Soon After the EMIC Program

For Cath, this period was characterised by her reflection on her classroom experimentation and her application of ideas into her ongoing mathematics teaching practice.

Reflecting on and applying Teaching Strategies

During Interview 2, Cath reflected on the nature of her exploration with respect to Teaching Strategies. She described a new awareness of how to use different strategies for teaching mathematics.

I’m more aware now of how I will go about things to make them more interesting or a bit more realistic, or a bit more practical. (Cath, Interview 2, p. 2)

Now when I do things I think of a bit more of a challenging way of presenting it. (Cath, Interview 2, p. 2)

We’re not doing so much work in our maths workbooks as we used to. Perhaps we’re doing more things in a group style fashion and thinking of other ways. (Cath, Interview 2, p. 2)

Cath described how the EMIC program acted as a stimulus for her exploration of different strategies for teaching mathematics.

I think it just brought it [ideas] more to the fore. Not that we didn’t do it in the past, but we’re doing more now. (Cath, Interview 2, p. 4)

I’d always done a lot of that [group work] in language work, social education and [the] science area, but I’d never really done as much
cooperative work or group work in maths. (Cath, Interview 2, p. 1)

I was really impressed with so many different types of activities that you can use that I wouldn’t have thought of in the past. (Cath, Interview 2, p. 2)

Cath also reported that she was applying the use of certain strategies to her ongoing mathematics teaching practice.

I’m doing more group or cooperative learning activities in maths than I did previously. (Cath, Interview 2, p. 1)

We’re doing visual displays more than we used to, rather than do it [record responses and solutions] on a piece of paper. (Cath, Interview 2, p. 2)

Observations in Cath’s classroom during this period confirmed her application of these strategies.

Reflecting on and applying Resource Use

When reflecting on her use of resources during this period, Cath noted that she was using more resources in her mathematics teaching.

I think we’re using what we did anyway. I feel we’re using them more often, or thinking about them more. (Cath, Interview 2, p. 4)

It seemed that Cath had become more conscious of her Resource Use. During lessons observed in this period, she made use of resources including: commercial publications (worksheets); school based publications (charts); mathematics teaching and learning equipment and materials (scales); technology (calculators); and general materials (newspapers, magazines and catalogues, food products). During Interview 2, she spoke of new resources she had used, including: commercial publications (miscellaneous commercial programs); general materials (miscellaneous materials); and human resources (the EMIC tutor).

Cath reflected on a new resource found through her participation in EMIC. She reported that she had come to appreciate Tanya, the EMIC tutor, as a resource she could seek advice and information from with respect to mathematics teaching.

One of the best things from doing the [EMIC] course is that now I know Tanya, and I could call on her to help or give some advice where necessary. (Cath, Interview 2, p. 5)
Exploring, reflecting on and applying Assessment Strategies

During this period, Cath reflected on her use of assessment strategies highlighting that while most strategies were not new to her practice, she had applied them more consistently since participating in EMIC.

I did a lot of things in the first place. ... EMIC wasn't a complete turn around revelation on what I already did. ... It more or less emphasised areas and things I'd done, but I'm doing them a bit more. (Cath, Interview 2, p. 5)

In classroom lessons observed across this period (see Vignettes 7.24–7.27), Cath applied assessment strategies including observation, questioning of students and self-assessment. During Observation 3 Cath explored a new strategy, anecdotal records. Cath reported that her exploration of anecdotal records in her classroom led her to value this assessment strategy.

One thing that we didn't do much before and I can see now is of really great value is the anecdotal one. (Cath, Interview 2, p. 5)

Ten to Twelve Months After the EMIC Program

During the period 10–12 months after the EMIC program, Cath applied several ideas to her ongoing practice and she engaged in reflection on that practice. She also reflected on ideas that were presented in the EMIC program.

Applying and reflecting on Teaching Strategies

During Interview 3 Cath reported the application of specific strategies presented during the EMIC program as part of her regular mathematics teaching practice.

Previously to that [EMIC] I hadn't included maths in group activities as much. (Cath, Interview 3, p. 2)

Problem solving things I've been using more. (Cath, Interview 3, p. 3)

Most of the strategies that were presented at EMIC were not new to Cath. However she stated that her participation in EMIC led her to apply the use of certain strategies in mathematics more consistently. She also reported that her use of the ideas presented in EMIC had become part of her teaching style. Rather than simply using one-off activities presented in the program, Cath considered that she had changed her overall approach to teaching mathematics.

I kind of use and adapt those styles [of teaching presented at EMIC]. (Cath, Interview 3, p. 2)
Now I more consciously think of things in that [EMIC] style to do. (Cath, Interview 3, p. 2)

I tend to develop my own ideas along the style of the EMIC ones that we did in the group [course]. (Cath, Interview 3, p. 1)

I feel that it's more of an integrated part of what the children are doing and not just a separate maths activity. (Cath, Interview 3, p. 2)

Applying and reflecting on Resource Use

During Interview 3, Cath reported that she used certain resources more often, and she considered that she had new knowledge with respect to how to use resources effectively. Cath indicated that she valued the ideas she had obtained through her involvement in EMIC.

I think it [EMIC] gave me an idea to use those sorts of things [general materials] more than I had. … They turned out to be the really good things sometimes and not necessarily things that required loads of complicated equipment. (Cath, Interview 3, p. 5)

Before EMIC … I used them [measuring equipment] in a slightly different way. In a less integrated way, and perhaps not in a group type way. (Cath, Interview 3, p. 5)

Reflecting on Assessment Strategies

During the classroom lesson observed in this period (see Vignette 7.26), Cath continued to use assessment strategies including observation, questioning of students, and checklists. While none of these strategies were new to Cath, it appeared that her use of some of these assessment strategies changed. Cath reported that the ideas with respect to assessment that were presented at EMIC provided the stimulus for her to spend more time observing students at work. She also stated that the kinds of teaching strategies that she was exploring, in particular group work, were most suited to the use of observation for assessing student performance. During Interview 3 Cath reported:

I think when children are working in groups and you’re not standing out the front delivering, you get a very good idea of being able to observe children. So you can observe the reactions and interactions of children, and what they can do or can’t do, or how they pick up on some quite innovative idea. Because you are able to observe them at work more easily …. I think perhaps it [ideas in EMIC] just gave me more time to stand back and look at them [students]. (Cath, Interview 3, p. 5)
Overview of changes in Cath's Classroom Practice

Table 7.4 displays an overview of the strategies and resources explored by Cath (these include both strategies and resources that were new to her mathematics teaching, and familiar strategies and resources that she used in new ways), and an overview of her changed knowledge and beliefs (in particular, new knowledge and beliefs).

<table>
<thead>
<tr>
<th>CLASSROOM PRACTICE COMPONENT</th>
<th>STRATEGIES AND RESOURCES EXPLORED</th>
<th>CHANGED KNOWLEDGE AND BELIEFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEACHING STRATEGIES</td>
<td>Student groupings&lt;br&gt;- groups&lt;br&gt;- pairs&lt;br&gt;Discourse types&lt;br&gt;- discussion&lt;br&gt;- student reporting&lt;br&gt;Task types&lt;br&gt;- problem solving tasks&lt;br&gt;- projects&lt;br&gt;Contexts&lt;br&gt;- theme work&lt;br&gt;- story shells&lt;br&gt;- songs/poems/literature&lt;br&gt;Teachers&lt;br&gt;- none explored</td>
<td>- awareness of new ways of using familiar strategies&lt;br&gt;- awareness of the efficacy of teaching strategies explored</td>
</tr>
<tr>
<td>RESOURCE USE</td>
<td>Commercial publications&lt;br&gt;- miscellaneous teacher books&lt;br&gt;- miscellaneous commercial programs&lt;br&gt;School based publications&lt;br&gt;- charts&lt;br&gt;Mathematics teaching and learning equipment and materials&lt;br&gt;- no new equipment explored&lt;br&gt;Technology&lt;br&gt;- calculators&lt;br&gt;General materials&lt;br&gt;- newspapers, catalogues&lt;br&gt;- cartons&lt;br&gt;- cardboard, string, tape&lt;br&gt;- food products&lt;br&gt;Human resources&lt;br&gt;- EMIC tutor&lt;br&gt;[Note: Cath used an increased number of resources for planning and teaching mathematics]</td>
<td>- awareness of new resources for teaching mathematics&lt;br&gt;- awareness of new ways of using familiar resources</td>
</tr>
<tr>
<td>ASSESSMENT STRATEGIES</td>
<td>Measurement strategies&lt;br&gt;- observation&lt;br&gt;- questioning&lt;br&gt;- student self-assessment&lt;br&gt;Recording strategies&lt;br&gt;- anecdotal records&lt;br&gt;- checklists</td>
<td>- awareness of new ways of using familiar assessment strategies&lt;br&gt;- awareness of the efficacy of assessment strategies explored</td>
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</table>
Cath explored a number of strategies and resources that were presented during the EMIC program (see Table 7.4). She developed some new knowledge and beliefs, and she applied some strategies and resources as part of her regular mathematics teaching practice. The changes in Cath's practice that were enduring and therefore represent growth are described in the next section.

7.5.3 Cath's professional growth

This section describes key aspects of Cath's professional growth with respect to each component of Classroom Practice, and the growth networks associated with that growth. Figure 7.12 displays an overview of Cath's growth networks with respect to each Classroom Practice component. Each of these components is discussed below.

<table>
<thead>
<tr>
<th>TEACHING STRATEGIES</th>
<th>RESOURCE USE</th>
<th>ASSESSMENT STRATEGIES</th>
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Figure 7.12. Cath's growth networks: Classroom Practice.

Growth with respect to Teaching Strategies

Cath's growth with respect to Teaching Strategies appeared to have been stimulated by her enactment of the ideas presented during EMIC sessions in her classroom, her reflection on her experimentation, and her reflection on the program ideas. Cath explored several teaching strategies, and she reflected on the practicalities of her explorations. She also reflected on the content of the EMIC program with respect to Teaching Strategies and Resource Use. Cath incorporated several strategies into her ongoing mathematics teaching practice, and she changed some of her views about mathematics teaching. Key aspects of Cath's growth with respect to Teaching Strategies included:

- an extended repertoire of strategies for teaching mathematics; and
- new beliefs related to the efficacy of teaching strategies explored.
Growth with respect to Resource Use

Across the time of the study Cath explored the use of many resources presented during EMIC sessions in her classroom. She also reflected on the nature of her experimentation with respect to Resource Use, and applied some new ideas related to Resource Use in her ongoing teaching practice. It appeared that, like Anne and Beth, Cath was primarily concerned with learning about new resources for teaching mathematics, and ways for using them (i.e. the nature of her resource use), rather than the consequences associated with her resource use. Key aspects of Cath’s growth with respect to Resource Use included:

- knowledge of new resources for teaching mathematics;
- knowledge of new ways of using familiar resources for teaching mathematics; and
- an increased use of resources for planning and teaching mathematics.

Growth with respect to Assessment Strategies

Cath’s growth in this area was stimulated by her enactment of ideas presented during the EMIC program, and her reflection on her exploration of assessment strategies. It appeared that few of the assessment strategies presented in the EMIC program were new to Cath, however she used certain strategies more frequently and in different ways than she had previously. She also viewed some strategies differently with respect to their efficacy. Key aspects of Cath’s growth with respect to Assessment Strategies included:

- knowledge of new ways of using familiar assessment strategies; and
- new beliefs related to the efficacy of assessment strategies explored.

Overall growth network associated with Cath’s Classroom Practice

Figure 7.13 displays the overall growth network associated with Cath’s growth with respect to Classroom Practice.
It appeared that, like Anne, Beth, and Brian, Cath was mostly concerned with the practicalities associated with changing her Classroom Practice (that is, how to implement changes). However with respect to Assessment Strategies she also considered the consequences (or outcomes) associated with changing her practice.

Other aspects of growth

When Cath became involved in EMIC, she demonstrated confidence and enthusiasm with respect to her mathematics teaching. Her motivation for participating in the program was to obtain further ideas and inspiration. It seemed that the EMIC course Cath attended met her expectations in these areas. Cath considered that she had obtained many practical ideas for use in her classroom and she felt confident in her ability to apply them.

I came back being able to do things and have a feeling of what it was all about. (Cath, Interview 3, p. 9)

It appeared that Cath changed her views of mathematics teaching, and she associated these changed views directly with her involvement in EMIC.

It [EMIC] gave me perhaps a new way of looking or a different angle to look at maths. A different way of looking at it. It definitely made me take more thought about making it more practical to everyday life. (Cath, Interview 3, p. 9)

I do more real things. Well, that's the way I see EMIC really, the fact that it is really relating things to everyday life. (Cath, Interview 3, p. 3)

It seemed that the ideas presented in the EMIC program provided a natural and timely extension for Cath with respect to her development as a mathematics teacher.
7.5.4 Critical factors associated with Cath's professional growth

The importance of the school environment

While Cath demonstrated confidence with respect to her ability to teach mathematics well, and enthusiasm to learn more about mathematics teaching, it seemed that she "missed" the active support of colleagues in her school. Early in the study, Cath highlighted what she considered to be a lack of interest in, and support for, mathematics in School C. In particular, Cath felt that the teaching of mathematics in the school needed to be supported by someone with a "passion" for the subject.

Unless you have got somebody who really has a passion for that subject and really pushes it forward in front of everybody all the time and keeps it going ... it's difficult. (Cath, Interview 1, p. 9)

Cath noted a distinct lack of support from the coordinator at her school with respect to participation in EMIC.

I did mention to the maths coordinator that I thought EMIC would be fantastic, and the comment was "I don't have time for that. I'm only interested in the grade". So that's fairly hard when you don't have that support. (Cath, Interview 1, p. 9)

Cath and one other staff member from School C attended the EMIC course investigated in this study, however it appeared that they did not often liaise with one another about the ideas presented in the program, or any other aspects associated with the course.

Across the time of the study Cath made several references to the difficulties associated with having few staff members from one school attending professional development activities. She considered that a coordinated approach to professional development throughout the school was needed.

When people do EMIC, I think it's a good idea if it was possible for the whole staff to do it. Because I think that's what you need. You need a coordinated approach where everybody at that particular time has done EMIC and then they know what you're on about. I think it's very difficult when you've [only] got two teachers [involved]. (Cath, Interview 2, p. 6)

I think that these things [professional development activities] are more meaningful if the school does them as a whole, because then you bring back to the whole school what you learn. Rather than have one person from here or three from there. I think it doesn't have that flow through. (Cath, Interview 3, p. 7)

It appeared that Cath felt no support from other staff members when she tried to share information she had obtained from the program with them. She suggested that
those staff members not directly involved in professional development do not have the same commitment to it.

That's the problem too when only a few people are doing it at once, it's feeding back information to the rest of the staff. Because people think, "oh here's something else". Unless you do it all together and get involved you get, "here's something else we have to think about". (Cath, Interview 3, p. 8)

In general Cath demonstrated enthusiasm for, and interest in, participating in the EMIC program. However it would seem from her comments, that factors associated with the environment of School C had a negative impact on her professional growth. The extent of this impact is not obvious.

7.6 The story of Debra

7.6.1 Debra in context

Teaching background

Debra had 18 years teaching experience in primary schools when the study commenced. As a classroom teacher she had taught students in Grades Prep to 4, and she had worked with groups of students in all grade levels. Just prior to the study, Debra had also worked as a special education consultant.

Debra was in her first year teaching at School D when she became involved in the EMIC program. She was working with a Prep class at that time. She also taught a Prep class during the second year of the study.

School context

School D, which was located in an inner southern suburb of Melbourne, had a student population of 350 and a full time teaching staff of 15.

Debra was the only member of staff attending the EMIC course investigated in this study. Two other teachers in the school had participated in EMIC previously.

Being new to the school, Debra felt unaware of how other teachers in School D taught mathematics. She was aware that most teachers used the commercial program Rigby (Iron & Scales, 1984) to plan their programs, and that there seemed to be an adequate
supply of materials and equipment in the school. She also reported that it appeared that there had been little recent work with respect to policy in the mathematics area.

Debra’s view of her mathematics teaching prior to EMIC

Debra’s comments with respect to her mathematics teaching prior to EMIC were very critical and indicated a lack of confidence. She reported that she felt concerned about her mathematics teaching.

I’m just overwhelmed .... I’m very critical with [of] the way I’m doing maths. I’m not happy with it at all.
(Debra, Interview 1, p. 3)

I don’t think there is really anything that I would say “this is good”. I think it’s really a fairly mundane type of program.
(Debra, Interview 1, p. 3)

Debra stated that she used the commercial program Rigby (Iron & Scales, 1984) as a basis for her planning, but she felt that it was not adequate.

I can’t see a pattern, a logical pattern [with respect to planning] so I’m taking it pretty much from the top and sticking to Rigby for the basis and working through those ideas that they’re offering .... [but]
I need some ideas, more than is in Rigby I think, to really develop their potential. I mean I use the Rigby sheets and things but I really don’t feel happy with them. I think there have got to be better ways to maximise their learning, so that it’s better learning.
(Debra, Interview 1, p. 3)

Debra appeared to be aware of some non-traditional strategies for teaching mathematics, however she did not know how to access ideas for teaching at the prep level. She stated that she wanted to explore problem solving and open-ended activities but that she was “grappling for ideas” (Debra, Interview 1, p. 2). Debra attributed her lack of confidence and knowledge to the fact that in recent years in her role as special education consultant she had little experience in teaching mathematics.

Involvement in EMIC

Debra was enthusiastic about participating in EMIC as she wanted to “learn more about the current situation in the primary maths area” (Debra, Interview 1, p. 1). In particular, Debra made continual reference to the seeking of ideas for teaching mathematics in the early years. The fact that Debra had not been in a classroom teaching position for some time, and the lack of confidence associated with this situation, made Debra keen to be involved in EMIC.
### 7.6.2 Debra’s Classroom Practice

**Vignettes and change sequences**

Vignettes 7.29–7.36 provide outlines of the lessons observed in Debra’s classroom to set the context for the discussion which follows.

Vignettes 7.29, 7.30, 7.31, 7.32, 7.33, 7.34, 7.35 and 7.36

**Vignettes of Lessons Observed: Debra**

#### During the EMIC Program

<table>
<thead>
<tr>
<th>VIGNETTE 7.29</th>
<th>VIGNETTE 7.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: Observation 1, June, Grade Prep)</td>
<td>(Source: Observation 2, August, Grade Prep)</td>
</tr>
<tr>
<td>During this lesson Debra involved students in a range of tasks related to patterns. She began the lesson with a discussion related to the patterns displayed in a picture of a school ground from the commercial program, <em>Righty</em> (Iron &amp; Scales, 1984). She then involved the students in a physical activity where they were required to create patterns based on physical features (for example, eye colour, hair length). The students then used a variety of concrete materials (e.g. attribute blocks, centicubes, building blocks and cards) to explore patterns. Debra encouraged the students to look at each others’ patterns and to describe them. For the remainder of the lesson the students explored making patterns with different materials. Debra observed students as they worked, asked questions of them when she considered it appropriate, and recorded assessment information on a class checklist.</td>
<td>During this lesson Debra had assistance from 2 other teachers as part of a language assistance program. Debra organised the students into 3 groups, one group working with each teacher for 15 minutes and then rotating. The activities which were all practical related to the content areas: mass, area and shape. A variety of resources were used by the different student groups. Debra prepared class checklists for each teacher to record assessment information as the students worked on the tasks. Debra observed the students in her groups as they worked and she asked questions of them when she considered it appropriate. Towards the end of the lesson Debra asked a number of students to report on the activities they had completed.</td>
</tr>
</tbody>
</table>

#### Soon After the EMIC Program

<table>
<thead>
<tr>
<th>VIGNETTE 7.31</th>
<th>VIGNETTE 7.32</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: Observation 3, October, Grade Prep)</td>
<td>(Source: Observation 4, December, Grade Prep)</td>
</tr>
<tr>
<td>Debra involved the class in chanting a number rhyme to introduce this lesson. She used a picture story book as a stimulus, and asked the students to role play the story of the rhyme. Debra then explained five different number tasks. She organised the students into groups and allocated each group an activity to start on. All of the activities focused on counting, ordering, and number patterns with numbers to 10. The students worked independently on the different tasks for the remainder of the lesson.</td>
<td>This lesson began with some whole class oral counting tasks led by Debra. The students were first encouraged to count by ones as far as they could, and then Debra asked a range of number questions (e.g. what number comes after 42?). Debra then explained three tasks which related to money. The tasks involved estimation of the cost of Christmas gifts in catalogues, a worksheet related to Christmas gifts, and a coin matching task (using plastic coins). The students worked independently to complete the tasks. To conclude the lesson Debra encouraged the students to share their findings with respect to the tasks.</td>
</tr>
</tbody>
</table>
Soon After the EMIC Program (cont.)

<table>
<thead>
<tr>
<th>VIGNETTE 7.33</th>
<th>VIGNETTE 7.34</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Source: Observation 6, March, Grade Prep)</strong></td>
<td><strong>(Source: Observation 6, April, Grade Prep)</strong></td>
</tr>
<tr>
<td>Debra involved the class in a number of different oral counting activities to introduce this lesson. She then led a discussion focused on the number 4. Debra then explained four tasks related to the number 4 that she had prepared. The tasks involved counting and sorting into groups of 4, and drawing 4 items. The students worked independently on these tasks. Towards the end of the lesson Debra encouraged the students to share their ideas related to the tasks.</td>
<td>During this lesson Debra had the assistance of another teacher as part of the school's language assistance program. The lesson comprised two different tasks. One involved the students in cooking and the other involved practical tasks related to the content area volume. The students worked in two groups, one with each teacher. At the end of the lesson Debra led a class discussion related to volume and estimation. She modelled the use of different terms associated with volume during this discussion.</td>
</tr>
</tbody>
</table>

10–12 Months After the EMIC Program

<table>
<thead>
<tr>
<th>VIGNETTE 7.35</th>
<th>VIGNETTE 7.16</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Source: Observation 7, June, Grade Prep)</strong></td>
<td><strong>(Source: Observation 8, July, Grade Prep)</strong></td>
</tr>
<tr>
<td>To introduce this lesson Debra used a big book (&quot;Grandpa, Granda&quot;) to involve the class in shared reading. She questioned the students about the numbers mentioned in the story. She then involved the students in a number game (&quot;Tic Tac Toe&quot;). Debra then led a discussion about other games the students were aware of emphasising how the games worked. She then presented the class with a large die and several large circles made of coloured cardboard and she challenged the students to think of ways they could use those materials to create their own game. The students discussed and demonstrated their ideas, and Debra talked about possible modifications to the games created. She then explained a task related to games from the commercial program Rigby (Iron &amp; Scales, 1984), and for the remainder of the lesson the students worked in pairs on that task.</td>
<td>As in Observation 7, Debra introduced this lesson using a picture story book (&quot;The Hungry Chickens&quot;). She then involved the class in a discussion focused on ordering numbers and an associated physical activity that required the students to role play. Debra then read a second story (&quot;The Enormous Watermelon&quot;) and discussed each character's order in the story. She then explained a worksheet task that required the students to place a number of pictures from a well known fairy tale in order. The students worked independently to complete the ordering task. Towards the end of the lesson the students worked in small groups to play ordering games using flashcards that displayed digits and letters.</td>
</tr>
</tbody>
</table>

Figure 7.14 displays an overview of the change sequences associated with Debra’s professional growth in the different study time periods. Each of these periods is discussed below.
During the EMIC Program

The data collected provided evidence that this was a period of exploration for Debra with respect to her Classroom Practice. She engaged in classroom experimentation with Teaching Strategies, Resource Use and Assessment Strategies ideas, that were presented in EMIC sessions.

Exploring Teaching Strategies

During classroom lessons observed in this period (see Vignettes 7.29 & 7.30), Debra explored several teaching strategies presented during EMIC sessions that were new to her mathematics teaching. These included: groups (student groupings); discussion (discourse types); and physical activities and practical tasks (task types). One teaching strategy that was new to Debra was the discussion of strategies used by students to complete mathematical tasks. During Observation 1 Debra discussed with students the strategies they used to create number and shape patterns. During Observation 2 she encouraged students to discuss the processes they used to complete different practical tasks. The “discussion” of students’ mathematics strategies was emphasised by Tanya, the EMIC tutor, during EMIC sessions, and emphasised in the EMIC program documentation (see Ministry of Education, 1990a).

Exploring Resource Use

During Observations 1 and 2 (see Vignettes 7.29 & 7.30), Debra explored the use of a number of resource ideas presented during EMIC, including general materials (digit cards, food products) and human resources (the students themselves). The use of a
variety of materials for teaching mathematics was emphasised by Tanya during EMIC sessions.

**Exploring Assessment Strategies**

During Interview 1 Debra made few comments with respect to assessment. She stated that she had no set procedure for assessing student learning in mathematics, and she reported a lack of knowledge in this area.

During classroom lessons observed in this period (see Vignettes 7.29 & 7.30), it was obvious that she was exploring several new assessment strategies that were emphasised in the EMIC program. These included: observation; questioning of students; work samples; and checklists.

**Soon After the EMIC Program**

The data collected provided evidence that during the period soon after the EMIC program Debra continued to explore some ideas that were presented in EMIC, and she engaged in much reflection. She reflected on the classroom practicalities of the new ideas she was exploring with respect to each component of Classroom Practice, and she applied some new knowledge with respect to Teaching Strategies and Resource Use in her ongoing practice. She also considered some student responses, and her own response, to her exploration of Teaching Strategies as positive salient outcomes.

**Exploring, reflecting on and applying Teaching Strategies**

During this period Debra explored some further teaching strategies that were new to her mathematics teaching. During Observations 3, 4, 5, and 6 (see Vignettes 7.31–7.34) she explored strategies including: oral tasks and problem solving (task types); and role play, songs, literature, and theme work (contexts).

When reflecting on her practice during Interview 2, Debra reported that she had changed her view of how she used different teaching strategies.

> I might have just done sheet work or something and that would have been what I thought was an adequate lesson. There might be more stages to it now or it might relate back to the theme a bit more often. (Debra, Interview 2, p. 5)

> Rather than use sheets too often I try and work out how they can do something a bit more practical. (Debra, Interview 2, p. 4)

She also reported her application of certain strategies, for example, "there's more discussion [in mathematics lessons now]" (Debra, Interview 2, p. 2).
Debra interpreted her own response to her exploration of Teaching Strategies as positive salient outcomes. For example she appeared to find more interest and satisfaction with respect to her teaching when she explored some of these new strategies.

A few things we've tried have been really quite interesting. It's made maths much more alive, and so therefore more meaningful. (Debra, Interview 2, p. 2)

I'm finding it more interesting too. It's a much more fun approach. (Debra, Interview 2, p. 3)

That [physical activity] worked very well .... It's just great to watch. (Debra, Interview 2, p. 2)

She also considered that her students enjoyed the strategies she was exploring.

They really loved that [calculator activity]. (Debra, Interview 2, p. 3)

Reflecting on and applying Resource Use

During Interview 2 Debra reflected on her use of different resources she had learnt about at EMIC. She considered that she had become more aware of available resources, how to access them, and how to use them effectively.

I've got a few more references and I know some of the references that are really good for infants, in fact probably the whole school. (Debra, Interview 2, p. 1)

It's sort of broken down the barriers for me having come back into a school and knowing who to go to for maths has helped. (Debra, Interview 2, p. 1)

One of the things that hit me actually was that we don't have to spend a lot, that there's stuff [general materials] already there. (Debra, Interview 2, p. 4)

Debra spoke of her application of particular resource use ideas presented in EMIC.

We're using a lot of those problem solving activities [presented during EMIC]. (Debra, Interview 2, p. 4)

She also referred to the people resources that she had come to value through her involvement in EMIC.

I can go now and I can even ring Tanya. (Debra, Interview 2, p. 1)

I've already used one of the girls in the [EMIC] group who's been a fantastic contact. (Debra, Interview 2, p. 1)
Reflecting on Assessment Strategies

During this period it was evident that Debra considered that her exploration of some assessment strategies presented during EMIC had been useful, in particular checklists used to record observations of students.

The thing I’ve done mostly is having a sheet of names beside me, and I’ve found that’s really good for quickly checking off what the kids are doing. (Debra, Interview 2, p. 5)

I was floundering a bit, wondering what to do [prior to EMIC]. ... This way [checklist] almost anything we do can be quickly checked off. I’m still not doing as much as I would like, but it’s a starting point, and there’s that [EMIC] information there to go to. (Debra, Interview 2, p. 5)

Ten to Twelve Months After the EMIC Program

During this period Debra applied several ideas to her ongoing practice and she engaged in reflection on that practice.

Applying and reflecting on Teaching Strategies

During lessons observed in Debra’s classroom in this period she applied many of the teaching strategies she had explored in earlier periods (see Vignettes 7.35 & 7.36). Debra made few comments however with respect to specific teaching strategies during Interview 3. Comments she made during this interview were general in nature, referring to changes to her mathematics teaching overall. These comments (several of which were linked to her exploration and application of different teaching strategies) will be presented in the discussion of her reflection on her overall practice in Section 7.6.3.

Applying and reflecting on Resource Use

During Interview 3 Debra reported her application of resource use ideas into her ongoing practice.

[I’m] referring to a broader range of materials and aids and things. I’m trying to do that. (Debra, Interview 3, p. 1)

[We’re] using more materials. (Debra, Interview 3, p. 3)

Debra also spoke in detail about her new knowledge with respect to resource use. She spoke of her increased awareness of resources, and of her new knowledge of ways in which different resources can be used.
I've now got the MCTP book and Nursery RIME [resource books referred to during EMIC]. So recently I've been using those and asking others to have a look. (Debra, Interview 3, p. 1)

[I'm] not worrying about expensive materials. ... The idea that we didn't have to necessarily buy or purchase anything special. (Debra, Interview 3, p. 3)

I think I probably use blocks in a broader way and all that basic equipment. ... There are more things you can do with them. (Debra, Interview 3, p. 4)

I probably look at a piece of equipment and think of a variety of ways it could be used, not just what it has been made for. (Debra, Interview 3, p. 4)

Applying and reflecting on Assessment Strategies

During Interview 3 Debra reported that she had consolidated some changed practices with respect to assessing student performance. In particular she felt she had improved her observation of students and the recording of student assessment information.

I assess what I'm doing a bit more carefully. (Debra, Interview 3, p. 2)

I'm more interested in what they [students] have got to say about things. (Debra, Interview 3, p. 3)

I guess I'm just a little bit more observant, trying to tune in to what they [students] are doing and why they're doing it. (Debra, Interview 3, p. 5)

I remember the checklist approach and just observing and watching what was happening. And listening. Keeping records like that in maths was new. (Debra, Interview 3, p. 5)

Debra also appeared to have changed her beliefs with respect to the efficacy of assessment strategies explored, including checklists.

I think the checklists will be a much better way to go than a formal test because you've got a bit more information, and you can keep adding to it. I like that form of assessment better than any really. (Debra, Interview 3, p. 5)

Overview of changes in Debra's Classroom Practice

Table 7.5 displays an overview of the strategies and resources explored by Debra (these include both strategies and resources that were new to her mathematics teaching, and familiar strategies and resources that she used in new ways), and an overview of her changed knowledge and beliefs (in particular, new knowledge and beliefs).
Table 7.5
Debra's Classroom Practice: Overview of Strategies and Resources Explored and Changed Knowledge and Beliefs

<table>
<thead>
<tr>
<th>CLASSROOM PRACTICE COMPONENT</th>
<th>STRATEGIES AND RESOURCES EXPLORED</th>
<th>CHANGED KNOWLEDGE AND BELIEFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEACHING STRATEGIES</td>
<td><em>Student groupings</em></td>
<td>- awareness of new strategies for teaching mathematics</td>
</tr>
<tr>
<td></td>
<td>- whole class</td>
<td>- awareness of the need to use a variety of strategies for teaching mathematics</td>
</tr>
<tr>
<td></td>
<td>- groups</td>
<td>- awareness of the efficacy of teaching strategies explored</td>
</tr>
<tr>
<td></td>
<td>- pairs</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Discourse types</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- discussion</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Task types</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- practical tasks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- physical activities</td>
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<tr>
<td></td>
<td>- oral tasks</td>
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<tr>
<td></td>
<td>- problem solving/open ended tasks</td>
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<td></td>
<td>- games</td>
<td></td>
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<tr>
<td></td>
<td><em>Contexts</em></td>
<td></td>
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<td></td>
<td>- theme work</td>
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<tr>
<td></td>
<td>- role play/drama</td>
<td></td>
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<tr>
<td></td>
<td>- songs/poems/literature</td>
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<tr>
<td></td>
<td>- story shells</td>
<td></td>
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<tr>
<td></td>
<td><em>Teachers</em></td>
<td></td>
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<tr>
<td></td>
<td>- team teaching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- cross-age tutoring</td>
<td></td>
</tr>
</tbody>
</table>

| RESOURCE USE                 | *Commercial publications*         | - awareness of new resources for teaching mathematics |
|                              |   - commercial program books      | - awareness of new ways of using existing resources |
|                              |   - children's literature         |                              |
|                              | *School based publications*       |                              |
|                              |   - problem solving boxes         |                              |
|                              |   - charts                        |                              |
|                              | *Mathematics teaching and learning equipment and materials* |                              |
|                              |   - no new equipment explored, however more equipment used |                              |
|                              | *Technology*                      |                              |
|                              |   - calculators                   |                              |
|                              | *General materials*               |                              |
|                              |   - food products                 |                              |
|                              |   - catalogues                    |                              |
|                              |   - cardboard, cards              |                              |
|                              |   - toys, mirrors                 |                              |
|                              | *Human resources*                 |                              |
|                              |   - students                      |                              |
|                              |   - EMIC tutor                    |                              |
|                              |   - colleagues                    |                              |

[Note: Debra used an increased number of resources for planning and teaching mathematics]

| ASSESSMENT STRATEGIES        | *Measurement strategies*          | - awareness of new strategies for assessing student learning in mathematics |
|                              |   - observation                   | - awareness of the efficacy of assessment strategies explored |
|                              |   - questioning                   |                              |
|                              |   - work samples                  |                              |
|                              | *Recording strategies*            |                              |
|                              |   - checklists                    |                              |

Debra explored many strategies and resources that were presented during the EMIC program (see Table 7.5). She developed some new knowledge and beliefs, and she
applied some strategies and ideas as part of her regular mathematics teaching practice. The changes in Debra’s practice that were enduring and therefore represent growth are described in the next section.

7.6.3 Debra’s professional growth

This section describes key aspects of Debra’s professional growth with respect to each component of Classroom Practice, and the growth networks associated with that growth. Figure 7.15 displays an overview of Debra’s growth networks with respect to each Classroom Practice component. Each of these components is discussed below.

![Diagram](image)

**Figure 7.15.** Debra’s growth networks: Classroom Practice.

**Growth with respect to Teaching Strategies**

Debra’s growth with respect to Teaching Strategies appeared to have been stimulated by her enactment of the ideas presented during EMIC sessions in her classroom. Her classroom experimentation with several new teaching strategies, and the reflection on that experimentation, led her to incorporate several new strategies into her ongoing mathematics teaching practice. Key aspects of Debra’s growth with respect to Teaching Strategies included:

- knowledge of new strategies for teaching mathematics;
- an extended repertoire of teaching strategies;
- new beliefs related to the need to use a variety of strategies; and
- new beliefs related to the efficacy of teaching strategies explored.
Growth with respect to Resource Use

Debra explored several Resource Use ideas presented during EMIC sessions in her classroom. She reflected on the nature of her experimentation with respect to Resource Use, and she applied some Resource Use strategies in her ongoing teaching practice. Debra appeared primarily concerned with which resources to use, and how to use them (i.e. the nature of her resource use), rather than the consequences of her Resource Use. Key aspects of Debra’s growth with respect to Resource Use included:

- knowledge of new resources for teaching mathematics;
- knowledge of new ways of using familiar resources for teaching mathematics; and
- an increased use of resources for planning and teaching mathematics.

Growth with respect to Assessment Strategies

Debra’s growth in this area was stimulated by her enactment of ideas presented during the EMIC program, and her reflection with respect to her exploration of new assessment strategies. Debra applied some strategies in her ongoing practice (including observation and checklists to record information), however like Beth, she identified scope for further growth in this area. Key aspects of Debra’s growth with respect to Assessment Strategies included:

- knowledge of new strategies for assessing student learning in mathematics;
- an extended repertoire of assessment strategies; and
- new beliefs related to the efficacy of assessment strategies explored.

Overall growth network associated with Debra’s Classroom Practice

Figure 7.16 displays the overall growth network associated with Debra’s growth with respect to Classroom Practice.

![Diagram](image)

*Figure 7.16.* Debra’s overall growth network with respect to Classroom Practice.
While it appeared that Debra was primarily concerned with the practicalities associated with changing her Classroom Practice (that is, how to implement changes), the data provided evidence that she also considered the consequences (or outcomes) associated with changing her practice—in particular with respect to Teaching Strategies and Assessment Strategies.

Other aspects of growth

Increased confidence and a change in attitude towards mathematics teaching were two additional areas of growth for Debra. Across the time of the study Debra’s increased confidence became obvious during lessons observed in her classroom, and in comments she made during interviews and informal discussions.

I think I have changed the way I teach maths quite a bit. I’ve questioned it for quite a while and I feel more comfortable with it just recently, and much more willing to try a few things. I guess it’s given me more confidence, quite a bit more confidence in that area. (Debra, Interview 3, p. 8)

Associated with this increased confidence was what Debra described as a better sense of direction with respect to her mathematics teaching.

I feel more aware of where I want to go. (Debra, Interview 3, p. 4)

She reported that she felt confident enough to want to explore some of the new strategies she had learnt with other classes and levels.

I think I’d be more confident to have a go at things in the middle and upper school too even though I haven’t actually done it. I’d take a similar approach but use activities that would be hopefully suited for children at that level. (Debra, Interview 3, p. 8)

Another associated area of growth for Debra related to her attitude towards her mathematics teaching. During Interviews 2 and 3 Debra described a change in how she viewed the teaching of mathematics and, associated with this, she reported increased satisfaction in her mathematics teaching.

A few things we’ve tried have been really quite interesting. It’s made maths much more alive and so therefore much more meaningful (Debra, Interview 2, p. 2)

I’m enjoying it a lot more. I’m feeling more relaxed than I was initially. I was really worried about it at first. Now I’m just finding we give something a go and you get feedback from the children and build on that. And take another tack if it doesn’t work. (Debra, Interview 3, p. 3)
Now I probably look at maths sessions in a different way. I feel more confident to try those things [EMIC ideas] now. I feel that I’m in tune with them. (Debra, Interview 3, p. 1)

I’m just a little bit more confident to try things that aren’t as traditional. They’re not just a maths lesson. To really look at why I’m doing it, to try and make it a bit more alive. To relate it more to children’s experiences and also not panic if we don’t happen to record an output or a formal sort of algorithm. ... It’s a broader perception of maths I suppose generally. (Debra, Interview 3, p. 2)

I’m just looking at most things in a more mathematical way I guess. (Debra, Interview 3, p. 8)

Debra’s changed attitude appeared to be directly associated with her classroom experimentation of some of the ideas presented during EMIC sessions.

7.6.4 Critical factors associated with Debra’s professional growth

A practicality ethic

During the analysis of the data, it became obvious that Debra actively sought “ideas” for teaching mathematics. Her concern for gathering practical ideas that she could immediately make use of in her classroom appeared to be the prime motivation for her involvement in EMIC. Doyle and Ponder (1977) described this focus on practical issues with respect to professional development as the “practicality ethic”. They reported that “inservice messages which are seen as practical will be incorporated, at least tentatively, into teacher plans” (p. 2). Debra constantly referred to her quest for ideas across the time of the study—ideas in the form of activities, strategies, material resources, and human resources, and ideas that are provided, exchanged or shared.

We’ve had some good ones [professional development activities] where teachers have shared their good ideas and activities that were interesting. (Debra, Interview 1, p. 2)

I think that’s what I could do with. More help with some ideas, like this is a good, quick, practical sort of reference. I’m hoping EMIC might be good for that. (Debra, Interview 1, p. 4)

That general exchange [through involvement in professional development] is great ... It’s given us a wealth of ideas. (Debra, Interview 2, p. 7)

It’s not always easy to organise or practical, but ideally it would be nice to have a bit of sharing. (Debra, Interview 2, p. 6)

[I valued the] exposure to ... the way people were approaching their maths, the other people’s ideas in the group. (Debra, Interview 2, p. 2)
I think you need to link up somehow with other people and see what they're doing. ... I really wish there was a bit more contact. (Debra, Interview 3, p. 7)

Just to hear what classroom teachers were doing, it was good to have that exchange. (Debra, Interview 3, p. 8)

Debra's obvious concern for practical ideas may, in part, have been stimulated by her absence from classroom teaching in the years preceding her involvement in EMIC. In any case, it appeared to be a critical factor in determining the focus of her professional growth.

In the next chapter an overview of the professional growth of all of the teachers involved in the study, including similarities and differences in their growth, is presented.
Chapter 8
Phase Two: Teacher change and growth—
Outcomes demonstrated and reported

This chapter explores the professional growth of all of the teachers involved in the study. An overview of the changes demonstrated and reported by the teachers in each component of Classroom Practice is presented first. Then similarities and differences in the teachers’ growth with respect to Classroom Practice components and other aspects are described. This is followed by a discussion of critical factors associated with the teachers’ growth. The final section of this chapter summarises the teachers’ demonstrated and reported change and growth. An analysis of factors associated with professional development programs perceived as influencing growth will be reported in Chapter 9.

8.1 Overview of changes in the teachers’ Classroom Practice

In this section similarities and differences in the teachers’ changed Classroom Practice are examined. In particular, changes in the teachers’ Teaching Strategies, Resource Use and Assessment Strategies are described.

8.1.1 Teaching Strategies

Table 8.1 displays an overview of the teaching strategies explored by the teachers (these include both strategies that were new to their mathematics teaching and familiar strategies that they used in new ways), and an overview of their changed knowledge and beliefs (including both new knowledge and beliefs, and the consolidation of some existing beliefs). Similarities and differences with respect to the teachers’ changes in these areas are discussed below.
Table 8.1
Teaching Strategies: Overview of Strategies Explored and Changed Knowledge and Beliefs

<table>
<thead>
<tr>
<th>STRATEGIES EXPLORED</th>
<th>ALAN</th>
<th>ANNE</th>
<th>BETH</th>
<th>BRIAN</th>
<th>CATH</th>
<th>DEBRA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student groupings</td>
<td>whole class</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>groups</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>pairs</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Discourse types</td>
<td>discussion</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>student reporting</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task types</td>
<td>problem solving/ open ended tasks</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>practical tasks</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>physical tasks</td>
<td>x</td>
<td>x</td>
<td>x</td>
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</tr>
<tr>
<td></td>
<td>projects</td>
<td>x</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>games</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>oral tasks</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Contexts</td>
<td>theme work</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>story shells</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>songs/poems/ literature</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>role play/drama</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Teachers</td>
<td>team teaching</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>cross-age tutoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHANGED KNOWLEDGE AND BELIEFS</th>
<th>ALAN</th>
<th>ANNE</th>
<th>BETH</th>
<th>BRIAN</th>
<th>CATH</th>
<th>DEBRA</th>
</tr>
</thead>
<tbody>
<tr>
<td>awareness of new strategies for teaching mathematics</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>awareness of new ways of using familiar strategies</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>awareness of, or confirmed belief in, the need to use a variety of strategies for teaching mathematics</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>awareness of, or confirmed belief in, the efficacy of strategies explored</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Teaching Strategies explored

Student groupings

All six teachers involved in this study explored the use of small groups and pairs in mathematics lessons. The use of these student groupings was emphasised in the EMIC program. Several of the activities included in the program involved students working in small groups or pairs, and specific discussions related to the use of a variety of student groupings were included in EMIC sessions. Two teachers, Anne and Debra, also made use of whole class games and activities that were presented by Tanya.
during EMIC sessions. Whole class involvement in tasks like these was a new strategy for these teachers.

**Discourse types**

All of the teachers explored the use of discussions in their mathematics teaching. This was a strategy that was strongly emphasised throughout EMIC. An entire workshop was focused on students and teachers talking about mathematics (see, EMIC Unit 5: Children and teachers talking about mathematics in the classroom, Ministry of Education, 1990a), and ideas related to teachers and students discussing mathematics were also prominent in other units. The use of discussions during mathematics lessons was not new to the teachers. However, it appeared that following their participation in EMIC, all six teachers involved their students in more discussions about mathematics during lessons.

**Task types**

The teachers explored a number of different task types. Each of them commented on her/his exploration of problem solving and open ended tasks. These kinds of tasks were presented in most of the EMIC units, and all of the teachers adopted or adapted some of these. Other task types that were emphasised in the EMIC program were also explored by most teachers. For example, five teachers, Alan, Anne, Beth, Brian and Debra, explored practical tasks and games, and four teachers, Alan, Anne, Brian and Debra, involved their students in physical activities. It should be noted that Cath and Beth reported that they were familiar with many of the task types that were presented during EMIC. It appeared that rather than the program providing them with new ideas, it acted as a stimulus for their continued exploration in this area.

**Contexts**

Theme work and story shells were the two context types that most teachers explored. Five teachers, Alan, Anne, Beth, Cath and Debra, explored the use of theme work. These teachers were familiar with using themes as a context for teaching other curriculum areas, so the exploration of mathematics tasks related to themes may have appealed to them. Brian did not appear to use themes as a context for organising any of his teaching.

Four teachers, Anne, Brian, Cath and Debra, used story shells. The use of story shells was emphasised in the EMIC program, and Tanya demonstrated this strategy often during the course investigated in this study. Three teachers, Anne, Cath and Debra,
explored the use of songs, poems or literature to set a context for mathematics lessons. In addition, Debra also explored the use of role play.

The study did not reveal any obvious reasons why the teachers chose to explore some contexts and not others. However their selections are likely to have been associated with factors such as their current teaching situation (for example, they may have considered a certain context would work well for teaching a particular content area to the grade of students they were working with), their interests (for example, they may have been interested in exploring a particular new context), and their previous experience.

**Teachers**

Across the time of the study only three teachers explored the involvement of colleagues in their mathematics lessons. Beth and Brian worked together to team teach a unit of work related to fractions to their classes. They had not previously team taught mathematics lessons. However, because they were teaching students in the same grade levels, and they wanted to explore some strategies presented during EMIC, they decided to work together.

Debra worked with specialist English as a Second Language (ESL) and Integration teachers in some of her mathematics lessons. She was used to involving support teachers in her classroom programs in other curriculum areas, and as she developed confidence in exploring different strategies in mathematics, the involvement of other teachers in mathematics lessons appeared natural to her. Debra also involved students in cross-age tutoring.

It is interesting to note that while parent involvement was emphasised in the EMIC program (see, for example, EMIC Unit 9: Teachers, parents, children and mathematics, Ministry of Education, 1990a), none of the teachers in this study involved parents in their mathematics teaching programs. Reasons for this may have been related to the school contexts in which the teachers worked (for example, parent involvement in classroom programs was obvious only in some sections of School A and not in the other schools involved in this study), or individual teacher preferences (for example, some teachers appeared uncomfortable about involving parents in classroom programs).
Changed knowledge and beliefs

Four teachers, Alan, Anne, Brian, and Debra, reported and demonstrated new knowledge of different strategies for teaching mathematics. Beth and Cath felt they did not learn any new strategies. As a recent university graduate Beth had previously heard of the strategies presented during EMIC. However she noted that through participating in EMIC she developed new knowledge with respect to how to use familiar strategies more coherently. Cath similarly noted that at EMIC she learnt new ways of using familiar strategies.

All of the teachers appeared to change their beliefs with respect to the efficacy of strategies explored. Alan, Anne, Brian and Debra reported changed views of the effectiveness of certain strategies, while Cath and Beth reported that their participation in EMIC had led them to confirm their beliefs in the efficacy of strategies explored. Cath considered the strategies she was exploring to be effective in other curriculum areas and her expectations with respect to their use in mathematics were now similar. It appeared that Beth’s involvement in EMIC led her to consolidate beliefs developed earlier during her university program.

Debra and Anne also spoke of their new belief in the need to use a variety of strategies for teaching mathematics. This belief was demonstrated by the number of strategies they explored across the time of the study—this was particularly true for Debra (see Table 8.1). Beth also reported that her involvement in EMIC led her to confirm her belief in the need to use a variety of strategies for teaching mathematics.

It appeared that the teachers involved in this study selected teaching strategies to explore from the variety on offer in the EMIC program. Factors that seemed to influence their selection of particular strategies included:

- the emphases given to certain strategies in the EMIC program;
- the teachers’ previous experiences;
- the teachers’ interests; and
- the school contexts in which the teachers worked.
8.1.2 Resource Use

Table 8.2 displays an overview of the resources explored by the teachers (these include both resources that were new to their mathematics teaching and familiar resources that they used in new ways), and an overview of their changed knowledge and beliefs with respect to resource use (including both new knowledge and beliefs, and the consolidation of some existing beliefs). Similarities and differences with respect to the teachers’ changes in these areas are discussed below.

Resources explored

Commercial publications

Five teachers, Alan, Beth, Brian, Cath and Debra, explored some new commercial publications for teaching mathematics. Beth, Brian and Cath used miscellaneous teacher books, Alan and Debra used books from commercial program series (for example, Right, Iron & Scales, 1984), Beth and Debra used children’s literature, and Alan used materials published as part of the EMIC program. Anne was the only teacher who did not appear to explore any new commercial publications across the time of the study. There was no obvious reason for this. However, it seemed that instead of seeking new commercial publications, Anne made use of those she already had and, in addition, she explored other kinds of resources.

School based publications

The use of charts was explored by four teachers, Anne, Beth, Cath and Debra. Each of these teachers made charts to use with their students during mathematics lessons. It seems likely that Tanya’s use, during an EMIC session, of a chart that she had made, was the stimulus for these teachers’ exploration of charts in their mathematics lessons, as there was no specific reference to the use of charts in the EMIC program documents.

Mathematics teaching and learning equipment and materials

None of the teachers considered that they learnt of any new mathematics teaching and learning equipment or materials during EMIC. However three teachers reported that they felt they used more of these kinds of resources as a result of participating in EMIC. Tanya often referred to the use of mathematics teaching and learning equipment and materials, however she did not introduce any that were new to these
### Table 8.2

**Resource Use: Overview of Resources Explored and Changed Knowledge and Beliefs**

<table>
<thead>
<tr>
<th>RESOURCES EXPLORED</th>
<th>ALAN</th>
<th>ANNE</th>
<th>BETH</th>
<th>BRIAN</th>
<th>CATH</th>
<th>DEBRA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial publications</td>
<td>miscellaneous teacher books</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>commercial program books/worksheets</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>children’s literature</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>MCTP/RIME 5&amp;6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>EMIC materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>School based publications</td>
<td>units of work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>charts</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>problem solving boxes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Mathematics teaching and learning equipment and materials</td>
<td>miscellaneous materials (not “new”, however used more often)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Technology</td>
<td>calculators</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>computer software</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>General materials (non-mathematics teaching and learning specific)</td>
<td>magazines/catalogues/newspapers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>boxes/packages</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cardboard/stickers</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>string/tape/streamers</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>miscellaneous materials (as listed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(sand, jugs, toys)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(matchsticks)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(playing cards)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(food)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(food, toys, mirrors)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human resources</td>
<td>colleagues</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EMIC tutor</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| CHANGED KNOWLEDGE AND BELIEFS

- **awareness of new resources for teaching mathematics**: x x x x x x
- **awareness of new ways of using familiar resources**: x x x x x x
- **awareness of, or confirmed belief in, the need to use a variety of resources for program planning**: x
- **awareness of the efficacy of resources explored**: x
teachers. It appeared that in the EMIC program there was an emphasis on selecting appropriate materials and using them effectively, rather than on introducing new materials.

Technology

All six teachers explored the use of calculators in their mathematics teaching. Each of the teachers reported that they had learnt of effective ways of using calculators through their involvement in EMIC. While there was no specific unit in EMIC that explored calculator use, tutors were encouraged to address important issues, including technology, "as they arise during the course" (Ministry of Education, 1990a, p. vii). During EMIC sessions Tanya explored activities that involved the use of calculators and she encouraged discussions related to their use.

General materials (non-mathematics teaching and learning specific)

The use of general materials was strongly emphasised by Tanya throughout the EMIC program. She often displayed student work samples that were created using general materials, as well as photographs of students using general materials as they worked on mathematical tasks. All of the teachers used a variety of these materials during the lessons observed in their classrooms, and several teachers commented on their new knowledge with respect to the use of general materials. It appeared that the teachers' use of these materials was stimulated by the emphasis placed on their use by Tanya, and also the frequent reference to their use in the EMIC program documents.

Human resources

All of the teachers explored the use of human resources. Five teachers, Alan, Anne, Beth, Brian and Debra, reported their exploration of ideas associated with working with colleagues—both colleagues in their own school, and in other schools. Alan, Anne, Beth and Brian reported increased involvement with colleagues from their schools with respect to talking about mathematics teaching. The mathematics ethos in School A and School B was positive, and there was an obvious commitment in these schools to ideas associated with the EMIC program. It appeared that the participation in EMIC of a large number of staff from these schools had a positive affect on Alan, Anne, Beth and Brian.

Debra did not experience such a positive and supportive school environment at School D. However, she formed a support network of colleagues from other schools whom she had met during EMIC. Beth and Brian also appeared to value the
interaction with colleagues from other schools that was encouraged in the EMIC program.

Four teachers, Alan, Anne, Cath and Debra, reported that they considered Tanya to be a resource person from whom they could seek assistance. Because Tanya worked with Alan and Anne at School A, they were able to seek her support and assistance often. Debra actively sought contact with Tanya to gain advice and ideas. Cath had little contact with Tanya, however she stated that she appreciated meeting Tanya and knowing that she could contact her if she needed to. Beth and Brian did not express a need for extra assistance or support from Tanya. This may have been because at School B they had developed a strong sense of collegiality due to the large number of teachers involved in EMIC.

One of the stated aims of the EMIC program was to give teachers the opportunity to work cooperatively with other teachers (see Ministry of Education, 1990a). It seems that the teachers in this study came to value their colleagues, and in particular Tanya, as resources in themselves.

*Changed knowledge and beliefs*

All of the teachers in this study developed their awareness of new resources and new ways of using familiar resources. This is not surprising considering that many references to resources are made throughout the EMIC program documents (see Ministry of Education, 1990a). In addition, during each EMIC workshop Tanya displayed a variety of resource publications and materials.

### 8.1.3 Assessment Strategies

Table 8.3 displays an overview of the assessment strategies explored by the teachers (these include both strategies that were new to their mathematics teaching and familiar strategies that they used in new ways), and an overview of their changed knowledge and beliefs with respect to assessing student learning in mathematics (in particular, new knowledge and beliefs). Similarities and differences with respect to the teachers' changes in these areas are discussed below.
### Table 8.3
Assessment Strategies: Overview of Strategies Explored and Changed Knowledge and Beliefs

<table>
<thead>
<tr>
<th>STRATEGIES EXPLORED</th>
<th>ALAN</th>
<th>ANNE</th>
<th>BETH</th>
<th>BRIAN</th>
<th>CATH</th>
<th>DEBRA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>observation</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>questioning/</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>interviewing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>student self-</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>assessment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>work samples</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Recording</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>anecdotal records</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>checklists</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHANGED KNOWLEDGE AND BELIEFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>awareness of new strategies for assessing student learning in mathematics</td>
</tr>
<tr>
<td>awareness of new ways of using familiar assessment strategies</td>
</tr>
<tr>
<td>awareness of the need to use a variety of assessment strategies in mathematics</td>
</tr>
<tr>
<td>awareness of the efficacy of assessment strategies explored</td>
</tr>
</tbody>
</table>

**Assessment Strategies explored**

**Measurement strategies**

With respect to measurement strategies, all six teachers explored observation and questioning, three teachers, Beth, Brian and Cath, explored student self-assessment, and one teacher, Debra, explored work samples. The use of these kinds of assessment strategies was strongly emphasised in EMIC—in particular there was a focus on observation and questioning (see, for example, EMIC Unit 2: Observing and listening to children, and Unit 8: Collecting quality assessment information in mathematics, Ministry of Education, 1990a). It appeared that the strong emphaeses on these strategies in the EMIC program encouraged the teachers to explore them.

**Recording strategies**

Five teachers, Alan, Anne, Beth, Brian and Cath, explored the use of anecdotal records, and four teachers, Anne, Brian, Cath and Debra, explored checklists for recording assessment information. Each of these recording strategies was specifically examined during Unit 8 of the EMIC program and, in addition, teachers were
encouraged to explore these strategies in some of the between session classroom explorations that were part of the program. For some teachers, the selection of recording strategies to explore appeared to be associated with their exploration of certain measurement strategies (see Table 8.3). For example, some teachers used anecdotal records and checklists to record assessment information obtained through observing students and questioning students. It also seemed that some teachers adapted assessment practices they had previously used. For example, some teachers adapted the use of checklists to suit their new teaching and assessment practices.

Changed knowledge and beliefs

Five teachers, Alan, Anne, Beth, Brian and Debra, reported an awareness of new strategies for assessing student learning in mathematics, and one teacher, Cath, reported an awareness of new ways of using familiar assessment strategies. Four teachers, Alan, Brian, Cath and Debra, changed their beliefs with respect to the efficacy of assessment strategies explored, and Alan and Anne expressed a new belief with respect to the need to use a variety of strategies to assess student learning in mathematics. All of the teachers appeared to develop some new knowledge or beliefs in this area.

It appeared that, as in the case of Teaching Strategies, the teachers selected assessment strategies to explore from those examined in the EMIC program. Moreover, the same kinds of factors appeared to influence their selections: the emphases given to certain strategies in the EMIC program; the teachers' previous experiences; the teachers' interests; and the school contexts in which the teachers worked. However, it seemed that a further factor influenced some teachers. This was the need to use assessment strategies that would enable them to effectively assess student learning as they explored new teaching strategies. That is, the teachers' explorations of new teaching strategies acted as a stimulus for their explorations of new assessment strategies.

8.1.4 Findings

It appeared from the analyses of the data that across the time of the study:
• all of the teachers explored some new Classroom Practice strategies or ideas in their classrooms;
• some obvious links existed between the Classroom Practice strategies and ideas explored by all or most of the teachers, and the kinds of strategies and ideas emphasised in the EMIC program; and
• there were differences in the teachers’ explorations of Classroom Practice strategies and ideas which appeared to be associated with their professional context (including: prior knowledge and experiences; interests; school location and grade level).

8.2 Overview of the teachers’ professional growth

8.2.1 Classroom Practice components

In this section the professional growth of the six teachers with respect to each component of Classroom Practice is examined. The discussions of each Classroom Practice component are presented in two parts. The first part outlines key areas of growth for the teachers. The second part describes the growth networks associated with the teachers’ growth. The Interconnected Model is used to represent the teachers’ growth networks.

Teaching Strategies

Key areas of growth

The data collected provided evidence that, with respect to Teaching Strategies, there were four main areas of growth demonstrated and reported by the teachers in this study. These were:
• knowledge of new strategies for teaching mathematics;
• an extended repertoire of teaching strategies;
• belief in the need to use a variety of strategies for teaching mathematics; and
• belief in the efficacy of teaching strategies explored.

Table 8.4 provides an overview of the areas of growth for the six teachers with respect to Teaching Strategies.
Table 8.4
Overview of Areas of Growth With Respect to Teaching Strategies

<table>
<thead>
<tr>
<th>AREA OF GROWTH</th>
<th>ALAN</th>
<th>ANNE</th>
<th>BETH</th>
<th>BRIAN</th>
<th>CATH</th>
<th>DEBRA</th>
</tr>
</thead>
<tbody>
<tr>
<td>• knowledge of new strategies</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• extended repertoire of strategies</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• belief in the need to use a variety of strategies</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>• belief in the efficacy of strategies explored</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Four teachers, Alan, Anne, Brian and Debra, developed knowledge of new strategies for teaching mathematics. These teachers had little or no experience with professional development in mathematics in the years prior to their participation in EMIC, and many of the teaching strategies presented in the program were new to them. However for Beth and Cath, there were few teaching strategies presented during EMIC that were new. Beth, a recent graduate, had been presented with current ideas related to mathematics teaching strategies during her university course, while Cath had developed knowledge of different teaching strategies through her experiences of professional development in other curriculum areas. For Cath, the application of these familiar strategies to her mathematics teaching was new.

Across the time of the study all of the teachers appeared to extend their repertoire of teaching strategies. Each of them applied some new strategies to their regular mathematics teaching practice. Even Beth and Cath, who were familiar with many of the strategies presented during EMIC, had not previously included those strategies as part of their ongoing teaching of mathematics. Their involvement in EMIC appeared to act as a stimulus for their continued exploration and subsequent application of certain teaching strategies.

Three teachers, Anne, Beth and Debra, changed their beliefs with respect to the use of a variety of strategies for teaching mathematics. Anne and Debra came to regard the use of a variety of strategies for teaching mathematics to be important, and this new belief was demonstrated in their classroom teaching. Beth's involvement in EMIC confirmed this belief for her.

It appeared from the data collected that all of the teachers changed their beliefs related to the efficacy of teaching strategies explored. Alan, Anne, Brian, Cath and Debra came to value the use of certain strategies for their mathematics teaching, while Beth's
participation in EMIC led her to consolidate beliefs related to the efficacy of certain strategies that she had developed earlier during university courses.

_Growth networks_

Figure 8.1 displays diagrams of the Interconnected Model which represent the growth networks associated with each teacher’s growth related to Teaching Strategies.

![Diagram of teachers' growth networks related to Teaching Strategies.](image)

*Figure 8.1.* The teachers' growth networks related to Teaching Strategies.

Four different growth networks representing the teachers' growth with respect to Teaching Strategies were identified using the Interconnected Model. Each of these networks is displayed and described below.

All six teachers enacted some ideas for teaching strategies presented in the EMIC program in their classroom, reflected on the practicalities associated with their exploration, and applied the use of some of the teaching strategies to their ongoing teaching practice.
Three teachers, Alan, Brian and Debra, enacted some ideas for teaching strategies presented during EMIC in their classrooms, then reflected on their explorations, interpreting some classroom behaviours associated with those explorations as salient outcomes. They then reflected on those outcomes, leading to changed beliefs with respect to certain strategies, and they applied the use of those strategies as part of their regular mathematics teaching practice.

Three teachers, Beth, Brian and Cath, directly reflected on the content of the EMIC program with respect to some teaching strategies, then applied some of these in their practice. Their subsequent reflection on their changed practice led them to develop some new knowledge and beliefs.

One teacher, Beth, enacted some ideas for teaching strategies presented during EMIC in her classroom and then reflected on her explorations interpreting some classroom behaviours associated with those explorations as salient outcomes. She then enacted some further related explorations in her classroom and reflected on the practicalities associated with those further explorations. This reflection led her to develop some new knowledge and beliefs which she then applied to her regular mathematics teaching practice.

What can be stated from an examination of the teachers' growth networks related to Teaching Strategies is that, for the teachers in this study, the process of professional growth stimulated by EMIC occurred primarily through reflection on classroom experimentation. All six teachers experimented in their classrooms with ideas presented in the EMIC program, and all six teachers engaged in reflection with respect to their experimentation—in particular, each of the teachers reflected on the practicalities associated with their changed practice. It appeared that the focus of the teachers' reflection was on "how" to implement new teaching strategies, rather than on any consequences associated with their changed practice. Only three teachers, Alan, Brian and Debra appeared to reflect on consequences. Teachers were encouraged in the EMIC sessions to reflect on both the practicalities and outcomes of their explorations with respect to teaching strategies (for example see Classroom
Exploration descriptions in the EMIC Participant's Logbook, Ministry of Education, 1990a). However, it appeared that they either interpreted a stronger emphasis with respect to reflecting on the practicalities of their explorations, or that they actually needed to attend to the practicalities associated with exploring new pedagogical territory prior to reflecting on any consequences.

Only three teachers appeared to reflect directly on the content of the EMIC program prior to experimentation. It is likely that this was due to the structural design of the program. There was a particularly strong emphasis on teachers exploring ideas in their classrooms and then reflecting on their explorations.

All six teachers applied some new teaching strategies to their ongoing practice. It seems that the stated aim of EMIC related to teachers trying out and adopting new teaching strategies (see Ministry of Education, 1990a, p. v) was realised for the teachers in this study.

Resource Use

**Key areas of growth**

There were four main areas of growth demonstrated and reported by the teachers in this study with respect to Resource Use. These were:

- knowledge of new resources for teaching mathematics;
- knowledge of new ways of using familiar resources for teaching mathematics;
- an increased use of resources for planning and teaching mathematics; and
- belief in the efficacy of resources explored.

Table 8.5 provides an overview of the areas of growth for the six teachers with respect to Resource Use.

**Table 8.5**

**Overview of Areas of Growth With Respect to Resource Use**

<table>
<thead>
<tr>
<th>AREA OF GROWTH</th>
<th>ALAN</th>
<th>ANNE</th>
<th>BETH</th>
<th>BRIAN</th>
<th>CATH</th>
<th>DEBRA</th>
</tr>
</thead>
<tbody>
<tr>
<td>knowledge of new resources</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>knowledge of new ways of using familiar resources</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>increased use of resources</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>belief in the efficacy of resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>
Across the time of the study all six teachers developed knowledge of some new resources for teaching mathematics, and knowledge of new ways of using familiar resources. These aspects of Resource Use were emphasised throughout the EMIC program and this obviously influenced the teachers' growth in this area.

Four teachers, Alan, Beth, Cath and Debra demonstrated and reported an increased use of resources for planning and teaching mathematics. These teachers considered that they used resources more often than they did prior to their involvement in the EMIC program. Observations in their classrooms supported these views. While the other two teachers, Anne and Brian, reported that they had become more aware of available resources and methods for using them, there was no evidence of their increased use of resources across the time of the study.

Brian was the only teacher who appeared to develop new beliefs related to the efficacy of resources explored. Brian reflected on his experimentation with resources and the consequences associated with this experimentation. Brian’s reflection on the outcomes of his experimentation led him to value the use of particular resources for teaching mathematics.

_Growth networks_

Figure 8.2 displays diagrams of the Interconnected Model which represent the growth networks associated with each teacher’s growth related to Resource Use.
Figure 8.2. The teachers’ growth networks related to Resource Use.

Four different growth networks representing the teachers’ growth with respect to Resource Use were identified using the Interconnected Model. Each of these networks is displayed and described below.

All six teachers explored resource ideas presented in the EMIC program in their classroom, reflected on the practicalities associated with their exploration, and applied the use of some resource ideas as part of their ongoing teaching practice.

On some occasions, one teacher, Alan, explored resource ideas presented in the EMIC program in his classroom, reflected on the practicalities associated with his exploration, and then sought additional external information with respect to resources. He then explored further ideas in his classroom, reflected on the nature of his changed practice, and applied the use of some new resource ideas to his ongoing mathematics teaching practice.
Another teacher, Brian, enacted in his classroom resource ideas presented in EMIC, reflected on his experimentation with respect to consequences, then reflected on those consequences and applied the use of some resource ideas to his ongoing practice.

One other teacher, Cath, reflected on the content of the EMIC program with respect to resource ideas, applied some of these ideas in practice, and then reflected on the nature of her changed practice related to resource use.

As in the case of Teaching Strategies, it appeared that the teachers’ professional growth with respect to Resource Use occurred primarily through their enactment in their classroom of ideas presented in EMIC and their reflection on their classroom experimentation—in particular, reflection on the practicalities of their changed practice with respect to Resource Use. This is not surprising given that the exploration of a variety of resources was explicitly encouraged throughout the EMIC program and, in addition, Tanya actively encouraged teachers to borrow and review resources provided by her in EMIC sessions.

**Assessment Strategies**

**Key areas of growth**

The data collected provided evidence that, with respect to Assessment Strategies, there were four main areas of growth demonstrated and reported by the teachers. These were:

- knowledge of new strategies for assessing student learning in mathematics;
- an extended repertoire of assessment strategies;
- belief in the efficacy of assessment strategies explored; and
- beliefs related to assessing student learning in mathematics.
Table 8.6 provides an overview of the areas of growth for the six teachers with respect to Assessment Strategies.

Table 8.6

<table>
<thead>
<tr>
<th>AREA OF GROWTH</th>
<th>ALAN</th>
<th>ANNE</th>
<th>BETH</th>
<th>BRIAN</th>
<th>CATH</th>
<th>DEBRA</th>
</tr>
</thead>
<tbody>
<tr>
<td>• knowledge of new assessment strategies</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>• knowledge of new ways of using familiar assessment strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>• extended repertoire of assessment strategies</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>• belief in the efficacy of assessment strategies explored</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>• beliefs related to assessing student learning</td>
<td>X</td>
<td>X</td>
<td></td>
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</tr>
</tbody>
</table>

Across the time of the study five teachers, Alan, Anne, Beth, Brian and Debra developed knowledge of new strategies for assessing student learning in mathematics. Each of these teachers perceived considerable growth in knowledge in this area. One teacher, Cath, considered that she developed knowledge of new ways of using familiar assessment strategies.

Four of the six teachers, Alan, Beth, Brian, and Debra, extended their repertoires of assessment strategies. Each one applied the use of some new assessment strategies as part of their regular practice with respect to assessing student learning in mathematics. Anne explored some new assessment strategies, and she appeared to change some of her beliefs with respect to assessment. However, there was no evidence to suggest that the strategies she had explored had become part of her ongoing assessment practice. Similarly, there was no evidence to suggest that Cath, who explored new ways of using familiar strategies, included those as part of her ongoing assessment practice.

Four teachers appeared to develop new beliefs with respect to the efficacy of assessment strategies explored. These teachers were Alan, Brian, Cath and Debra. These teachers came to value informal strategies such as observation, questioning of students and the keeping of anecdotal records. Two teachers, Anne and Brian, appeared to develop new beliefs related to the overall assessment of student learning in mathematics. These teachers considered that they had changed their views with respect to assessment. Furthermore, Brian felt that these changes in belief were reflected in the new approach he was using to assess his students.
Growth networks

Figure 8.3 displays diagrams of the Interconnected Model which represent the growth networks associated with each teacher’s growth related to Assessment Strategies.

Three different growth networks representing the teachers’ growth with respect to Assessment Strategies were identified using the Interconnected Model. Each of these networks is displayed and described below.

Five of the six teachers, Alan, Beth, Brian, Cath and Debra, enacted assessment ideas presented in the EMIC program in their classroom, reflected on the practicalities associated with their exploration, and applied the use of some assessment strategies in their regular assessment practice.

After exploring in their classrooms some assessment ideas presented in EMIC, three teachers, Alan, Cath and Debra, reflected on their explorations, interpreting some classroom behaviours associated with those explorations as salient
outcomes. They then reflected on those outcomes, which led to changed beliefs with respect to certain assessment ideas. They then applied those ideas to their regular mathematics assessment practice.

Two teachers, Anne and Brian, reflected on the content of the EMIC program with respect to assessment strategies, applied some of the strategies in practice, and then reflected on the use of those strategies.

For most of the teachers, the process of professional growth with respect to Assessment Strategies occurred primarily through reflection on classroom experimentation. Five teachers directly experimented in their classrooms with assessment ideas presented in the EMIC program, and each of those teachers reflected on their experimentation. The other teacher, Anne, reflected on the assessment ideas presented in the program prior to applying them in her classroom. Her subsequent reflection on her changed practice similarly led to growth with respect to new knowledge and beliefs in this area. Given that, throughout the EMIC program, teachers were encouraged to explore and consider adopting new assessment strategies, the teachers' growth in this area was not surprising.

Overall growth networks associated with Classroom Practice

Figure 8.4 displays diagrams of the Interconnected Model which represent the teachers' overall growth networks associated with their Classroom Practice.
All six teachers enacted some Classroom Practice ideas presented in the EMIC program in their classroom, reflected on the practicalities associated with their exploration, and applied the use of some of the ideas to their ongoing teaching practice.

Four teachers, Alan, Brian, Cath and Debra, enacted some Classroom Practice ideas presented during EMIC in their classrooms, then reflected on their explorations, interpreting some classroom behaviours associated with those explorations as salient outcomes. They then reflected on those outcomes, leading to changed beliefs, and applied the use of some ideas to their regular mathematics teaching practice.
Four of the teachers, Anne, Beth, Brian and Cath, directly reflected on the content of the EMIC program with respect to Classroom Practice ideas, then applied some of these in their practice. They then reflected on that practice, developing new knowledge and beliefs.

The growth network displayed here represents a growth process for one teacher, Beth. She enacted some ideas for Classroom Practice presented during EMIC in her classroom and then reflected on her explorations, interpreting some classroom behaviours associated with those explorations as salient outcomes. She then enacted some further related explorations in her classroom, reflected on the practicalities associated with her changed practice, and applied some ideas to her regular mathematics teaching practice.

What can be stated from an examination of the teachers’ growth networks with respect to Classroom Practice is that:

- all six teachers involved in this study were often concerned with the practicalities associated with implementing the Classroom Practice ideas presented in the EMIC program;
- all six teachers engaged in multiple growth processes—that is, each teacher’s growth is represented by two or more growth networks; and
- the professional growth of the six teachers in this study was idiosyncratic—both in terms of growth processes and outcomes; the teachers engaged in different growth processes (as represented by their unique combinations of growth networks), and the outcomes of their growth in each Classroom Practice area were individualistic.

**8.2.2 Other aspects of growth**

In this section similarities and differences with respect to other, more general aspects of the teachers’ growth are described. The analyses of the data provided evidence of three additional aspects of teacher professional growth. These were: confidence;
attitudes towards mathematics teaching; and beliefs with respect to mathematics teaching and learning. Each of these is discussed below.

**Confidence**

Five teachers, Alan, Anne, Beth, Brian, and Debra, reported increased confidence with respect to their mathematics teaching. Each of these teachers considered that their involvement in the EMIC program led them to feel more effective and relaxed about their mathematics teaching. Across the time of the study, lessons observed in the teachers’ classrooms confirmed these reports. Two teachers, however, tempered their comments related to their confidence levels. Beth and Brian considered their confidence had in fact increased, but they also acknowledged their need to develop further confidence in certain areas of their mathematics teaching. Brian’s recognition of the need for further growth in relation to his confidence level appeared to have been associated with some criticisms of the mathematics teaching at School B that were made by the parent community in the year prior to his involvement in EMIC. During Interview 3 Brian reported that some parents at School B had previously criticised what the teachers were doing in the mathematics area. Beth considered that as a relatively “young” teacher she had much to learn.

The teacher who reported no increase in confidence with respect to her mathematics teaching was Cath. She was very confident in her ability to teach mathematics prior to her involvement in EMIC. During Interview 1 conducted early in the study, she reported a love of mathematics, and mathematics teaching. It is therefore not surprising that Cath made no mention of any increase in confidence during the study.

One of the stated aims of the EMIC program was to give teachers the opportunity to “gain confidence as mathematics teachers” (Ministry of Education, 1990a, p. v). It appeared that for the teachers involved in this study this aim was met.

**Attitudes towards mathematics teaching**

A further aspect of growth reported and demonstrated by most of the teachers involved in the study related to their attitudes towards mathematics teaching. The same five teachers who developed increased confidence, also reported growth in this area. Alan, Anne, Beth, Brian and Debra all reported increased enthusiasm for, and satisfaction with, their mathematics teaching. While Cath did not report any change in attitude, she did acknowledge that she had felt inspired by the ideas presented during EMIC. It could be conjectured that the positive attitudes that most of the teachers
developed towards their mathematics teaching across the time of the study may have been linked to their increased confidence levels.

**Beliefs with respect to mathematics teaching and learning**

Three teachers appeared to develop some lasting changes in beliefs with respect to the teaching and learning of mathematics. Alan, Cath and Debra expressed changed views of mathematics, mathematics teaching, and the learning of mathematics. Each of these areas was explicitly examined in the EMIC program. Teachers were asked to consider what mathematics is, to reflect on their practice as teachers of mathematics, and to increase their awareness of how children learn mathematics (see Ministry of Education, 1990a). These teachers reported and demonstrated growth in these areas.

### 8.3 Critical factors associated with the teachers' growth

During the analyses of the data a number of critical factors associated with the growth of the teachers involved in this study emerged. A discussion of each of these critical factors, including the similarities and differences associated with each one for the different teachers involved in the study, is presented below.

#### 8.3.1 The school environment

The school environment appeared to be a critical factor in the professional growth of three of the teachers involved in this study, Alan, Anne, and Brian. Each of these teachers considered a positive and encouraging school environment to be conducive to supporting teacher professional growth. They referred to a number of conditions associated with such an environment. These included: a positive and strong mathematics ethos; a sense of collegiality; and a culture of professional (teacher) learning.

Across the time of the study, Alan and Anne experienced each of these conditions at School A. Under the enthusiastic guidance of Tanya, the EMIC tutor and mathematics coordinator, School A had developed a particularly positive and strong mathematics ethos and an obvious commitment to collegiality. The school had also developed a culture of professional learning. There were many opportunities for teachers in School A to participate in professional development activities and programs, both
within the school and externally. It appeared that with respect to the availability of resources, encouragement, and support, Alan and Anne were located in an optimal school environment for participating in mathematics professional development.

During the first year of the study, Brian experienced a developing sense of collegiality, a developing mathematics ethos, and a developing culture of teacher learning at School B. Brian reported that he felt the high level of involvement of staff from School B in the EMIC course investigated in this study (seven teachers), had a positive effect on himself, other staff, students and parents. In particular, Brian noted the heightened profile of mathematics as a learning area in the school, and he attributed this to the changed attitude towards teaching mathematics demonstrated by many teachers in the school. When he relocated to School Z part way through the study, Brian continued to refer to the positive effect he considered the involvement in EMIC of staff at School B had on the school. He also suggested that the changing school environment at School B at that time affected his personal professional growth.

While for other teachers in this study, the school environment did not appear to be a critical factor associated with their professional growth, it is interesting to note that the absence of some of the conditions discussed above appeared to cause some difficulties for Cath at School C, and Debra at School D. Cath considered that at School C there was a lack of coordination and leadership with respect to mathematics, little collegial activity, and no obvious commitment to professional development in the mathematics area. While Cath was obviously concerned about this situation, it did not appear to constrain her involvement in the EMIC program in any way. However the actual impact of her school environment on her professional growth at that time is not known.

For Debra, at School D, it appeared that "isolation" was a factor that affected her. Debra was the only staff member from School D involved in the EMIC course investigated in this study. On several occasions across the time of the study, Debra reported that she needed and wanted to be more involved with colleagues in order to discuss and share ideas. While she enjoyed the contact with teachers from other schools who were participants in the EMIC course, she considered that it would have been beneficial for her if more members of staff at School D had been involved.

Further discussion of the importance of the school environment with respect to professional growth will be presented in Chapter 11.
8.3.2 Experimentation and reflection

All of the teachers examined in this study engaged in experimentation and reflection. However for two of the teachers, Alan and Anne, the actual process of experimenting with the ideas presented during the EMIC program, and reflecting on that experimentation, seemed critical to their professional growth. Alan, in particular, engaged in much experimentation and reflection. He explored many of the ideas presented during EMIC and he spent considerable time reflecting on his explorations. Alan reflected on the practicalities associated with the use of new strategies and ideas. He also reflected on some consequences associated with his experimentation. It appeared that the structured components of the EMIC program that required teachers to try new ideas and approaches in their classroom, and to discuss the outcomes of their explorations, encouraged and supported Alan’s professional growth. This also appeared to be the case for Anne. While generally she was more passive than Alan with respect to exploring the EMIC ideas, it seemed that her classroom experimentation provided the stimulus for her to develop new beliefs and consequently to explore further ideas.

8.3.3 Other critical factors

There were three other factors that appeared critical to the professional growth of individual teachers. For Beth, the affirmation of her existing ideas with respect to good practice appeared to be a critical factor associated with her growth. Beth was aware of many of the ideas presented during EMIC, however she had not yet experienced a school environment where these ideas were accepted and used, and therefore she had felt uncomfortable about implementing them herself. Beth reported that the “legitimisation” of many of the ideas she believed in, but had not yet explored, was an important outcome of her participation in EMIC.

Motivation was a factor that appeared critical to Brian’s professional growth. His enthusiasm for learning more about mathematics teaching appeared to motivate him to actively participate in all of the EMIC program components. He explored the ideas presented in EMIC and reflected thoughtfully on the program content and his classroom experiences.

A critical factor that appeared to be associated with Debra’s professional growth was her concern for obtaining practical ideas for use in her classroom. Debra was
passionate about seeking ideas for teaching mathematics, and across the time of the study this became the focus of her professional growth.

Many of the factors discussed in this section are contextual in nature, relating to the setting for individual professional growth. The notion of the change environment and its effect on growth is explored in more detail in Chapter 11.

### 8.4 Change and growth demonstrated and reported

The specific research question that focused the examination of teacher growth in this study was: what change do primary teachers report and demonstrate in practice when they participate in a mathematics professional development program? Details of the teachers' reported and demonstrated change and growth were presented in Chapters 6 and 7, and in earlier sections of this chapter. This section summarises the findings associated with this research question.

All six teachers reported and demonstrated change and growth with respect to their mathematics teaching. In particular, the teachers reported and demonstrated:

- **the exploration and application of new strategies and ideas**
  - all of the teachers explored some new Classroom Practice strategies or ideas in their classrooms;
  - all of the teachers applied some new strategies to their ongoing teaching and assessment strategies repertoires;
  - some teachers increased their use of resources for planning and teaching mathematics.

- **changed knowledge and beliefs**
  - most teachers reported and demonstrated new knowledge of different strategies and ideas for teaching mathematics—some teachers reported new knowledge with respect to how to use familiar strategies more coherently;
  - all teachers changed their beliefs with respect to the efficacy of strategies and ideas explored—some changed their views of the effectiveness of certain strategies, and others confirmed their beliefs in the efficacy of strategies explored;
  - some teachers developed new beliefs related to the use of a variety of strategies for teaching mathematics;
  - some teachers developed new beliefs related to the overall assessment of student learning in mathematics;
- some teachers changed their views of mathematics, mathematics teaching, and the learning of mathematics.

- **changed confidence levels and changed attitudes towards mathematics teaching**
  - most teachers reported and demonstrated increased confidence with respect to their mathematics teaching;
  - most teachers reported and demonstrated more positive attitudes towards mathematics teaching.

With respect to the processes associated with the teachers’ change and growth, it was found that:

- the teachers’ professional growth occurred primarily through reflection on classroom experimentation—all of the teachers appeared to reflect on the practicalities associated with their changed practice more than the outcomes associated with their changed practice, and only some teachers appeared to reflect directly on the content of the EMIC program prior to experimentation;

- all of the teachers engaged in multiple growth processes—several different routes to change and growth were evident for all of the teachers; and

- the professional growth of the teachers was idiosyncratic with respect to growth processes—there were no patterns common to the teachers with respect to the kinds of growth processes they engaged in.

General findings associated with the teachers’ reported and demonstrated change and growth include:

- the teachers’ professional growth was idiosyncratic both in terms of growth processes and outcomes;

- factors that appeared to influence teacher change and growth include the emphases given to certain strategies and ideas in the EMIC program, teachers’ previous experience, teachers’ interests, and teachers’ current school contexts; and

- the school environment appeared to be a critical factor in the professional growth of several teachers.

In the next chapter factors associated with professional development programs perceived as influencing growth are examined.
Chapter 9
Phase Two: Examining teacher professional growth—
Perceptions of factors associated with mathematics professional development programs influencing growth

This chapter reports analyses of the data related to the teachers' and the tutor's views of professional development and, in particular, their views of the EMIC program. The discussion is presented in six sections: overview of factors perceived as influencing growth; program structure; program content; program presentation; relationships between the views of the teachers and tutor and the existing literature; and discussion of factors associated with professional development programs perceived as influencing growth.

In the following two chapters the findings associated with the major research question that guided this study will be interpreted and discussed, and conclusions and recommendations will be made.

9.1 An overview of factors perceived as influencing growth

During the structured interviews conducted in each of the study time periods, the six teachers were asked about their past and current professional development experiences, and their views of those experiences. The teachers' interview responses, together with comments they made during informal conversations across the time of the study, provided the main source of data for considering the factors associated with professional development programs that appeared to influence teacher growth.

In addition to the views of the teachers, the views of the EMIC program tutor regarding factors associated with professional development programs that appear to influence teacher growth were sought. During the tutor interview, conducted 12 months after the completion of the EMIC course examined in this study, the tutor was asked questions related to: her role as an EMIC tutor; the EMIC course examined in this study; the EMIC program in general; and professional development in general.
The teachers’ and tutor’s interview responses and comments were organised into categories of factors. These categories related to the:

- **program structure**—this category included factors associated with structural features of the professional development program (in particular, duration, participation, experimentation and reflection, collegiality and the sharing of ideas, support, and program resources);
- **program content**—this category included factors associated with the content of the professional development program (in particular, orientation and knowledge); and
- **program presentation**—this category included factors associated with the presenter of the professional development program (in particular, presentation style, credibility, and support provided).

A discussion of each of these categories follows.

### 9.2 Program structure

There were several structural features of the EMIC program that the teachers and tutor suggested might influence teacher growth. The EMIC tutor regarded the structural design of the program to be a significant factor in its success.

I think the reason for its [EMIC's] great success ... was the model. This supported change, supported [teacher] learning. The idea of coming each week, of having a break between some units, of having tasks to do when you’re away from the program. I think this is why it was so successful. There was a responsibility as a participant just as there was a responsibility from the tutor. And you had to show you were actively involved in the program. I think it’s the model that made it so successful, the same model that is in ELIC [Early Literacy Inservice Course]. I’m sure that’s the key to it—supported change. (Tutor Interview, p. 4)

This section describes the particular structural features that the teachers and tutor considered important. Table 9.1 displays an overview of the structural features of professional development programs in general, and the EMIC program in particular, perceived by the teachers and tutor to promote growth.
<table>
<thead>
<tr>
<th>STRUCTURAL FEATURES</th>
<th>PROFESSIONAL DEVELOPMENT IN GENERAL</th>
<th>FEATURES OF EMIC PERCEIVED TO INFLUENCE GROWTH</th>
</tr>
</thead>
</table>
| DURATION             | • one-off professional development sessions are ineffective (Anne, Brian)  
                         • long-term professional development is needed (Tanya) | • length of the program [10 sessions] was appropriate (Anne, Beth, Tanya) |
| PARTICIPATION        | • opportunities should be provided for participants to build professional networks and make contacts (Tanya)  
                         • opportunities should be provided for participants to develop collegiality (Tanya) | • involved groups of teachers from the same school (Beth, Brian, Cath, Tanya)  
                         • involved teachers from a number of schools (Brian, Debra)  
                         • provided opportunities for teachers to participate in change together (Tanya)  
                         • involved teachers in accepting professional responsibilities with respect to participation (Tanya) |
| SHARING IDEAS        | • opportunities should be provided for participants to share experiences and ideas (Alan, Beth, Debra, Tanya) | • provided structured opportunities for participants to share experiences and ideas; in particular through the program components “This Works For Me” and “Classroom Explorations” (Alan, Anne, Beth, Brian, Cath, Debra, Tanya) |
| EXPERIMENTATION AND REFLECTION | • opportunities should be provided for participants to explore ideas in their classrooms between professional development sessions (Tanya)  
                         • opportunities should be provided for participants to reflect on their teaching (Tanya) | • provided structured opportunities for classroom experimentation in the “Classroom Explorations” component (Alan, Beth, Debra, Tanya)  
                         • provided structured opportunities for participants to reflect on their mathematics teaching (Beth, Tanya) |
| SUPPORT              | • regular support from the professional development tutor/facilitator should be provided to participants (Tanya)  
                         • school and system level support and recognition should be provided to professional development participants (Tanya) | • ongoing support provided to participants by the EMIC tutor (Alan, Anne, Beth, Debra, Tanya) |
| RESOURCES            | • professionally prepared resource folders should be provided to professional development participants (Tanya)  
                         • professional readings should be included in professional development activities (Tanya) | • provided participants with a program logbook (Alan, Beth, Brian, Cath) |
9.2.1 Duration

A characteristic that appeared to be significant in influencing teacher growth was the extended or long term nature of the program. Four of the six teachers involved in this study, and the program tutor, suggested that time is a critical factor in encouraging and supporting professional growth.

Two teachers, Anne and Brian, emphasised the ineffectiveness of "one-off" professional development sessions. They reported that they were unable to remember information and ideas presented at these kinds of sessions and that they considered that such sessions brought about little change in practice.

During the tutor interview, Tanya reported her belief in the need to involve teachers in professional development that extended over long periods.

I think they [professional development programs] need to be spread out over a considerable time. I don't think teachers mind coming for ten weeks. I mean they complain, but if they're getting a lot out if it they're happy to come back the next time, try something, talk about it, try something, talk about it. (Tutor Interview, p. 8)

Tanya stated that she felt the length of the EMIC program was a significant factor in the program's success with respect to encouraging and supporting teacher growth.

Anne and Beth also regarded the length of the EMIC program as important.

The length of time, 10 weeks, is a good time because it's a new area for many people and you can't get all that information in just a few sessions. You need enough time to get through it all. (Anne, Interview 3, p. 6)

Beth highlighted the importance of an extended period of time for encouraging professional growth.

If you provide a long term thing like EMIC, which I think is one of its main pluses ... it gives people the opportunity to have a go bit by bit and to have support ... to try something new. (Beth, Interview 2, p. 6)

The format of EMIC and how it works over a period of time and asking people to go back to their classrooms and try it, and share, and very activity based is the only way to do it. (Beth, Interview 3, p. 6)

One teacher, Debra, felt that there was inadequate time in the 10 two-hour sessions to fully explore all that was in the EMIC program. She stated that she felt the program seemed, at times, too rushed. However, she was aware that she would continue to
explore the program content through further readings and classroom explorations following the program.

I guess one of the worst things about it was that we had to cram so much in the short time. It would be nice to have it stretched out. ... I think I will go back to it and read as I need it. But it was a lot to take on a weekly basis, to try and absorb it all.
(Debra, Interview 3, p. 7)

None of the teachers involved in this study suggested that the EMIC program was too long.

### 9.2.2 Participation

The participation in EMIC of groups of teachers from several schools was a structural feature of the program that some teachers, and the tutor, considered influenced growth.

Beth and Brian reported that the involvement in EMIC of a large number of teachers (seven) from School B influenced their individual professional growth in a positive way. They also reported that the involvement of many teachers had a positive effect on the teaching and learning of mathematics throughout the school. They described a school environment where teachers talked often about their involvement in EMIC and their subsequent classroom experimentation. Brian reported increased enthusiasm and confidence among the staff with respect to teaching mathematics, and he attributed this to the high profile that mathematics as a curriculum area developed in the school due to the involvement in EMIC of a large number of teachers.

Cath, one of only two staff members from School C who participated in the EMIC course examined in this study, implied that it was disadvantageous to have few staff involved. It appeared that Cath experienced some difficulties gaining support for the application of ideas from the EMIC program in her school.

I think it's a good idea if it was possible for the whole staff to do it because I think that's what you need. You need a coordinated approach where everybody at that particular time perhaps has done EMIC and then they know what you're on about. I think it's very difficult when you've got [only] two teachers. ... I would like to see it on a staff basis ... then it could flow through the school.
(Cath, Interview 2, p. 6)

For Debra, the involvement of teachers from schools other than her own was greatly valued. She appreciated the opportunity to make contacts with other teachers
working with students in the same grade level (Grade Prep). During interviews and informal discussions she often spoke about how her participation in EMIC led her to develop a network of teachers that she could call on for advice and support. However, on several occasions she also implied that she felt "isolated" with respect to her involvement in EMIC, as she was the only participant from School D in the course investigated in this study. Debra stated that she would have liked to discuss ideas related to her professional development experience with colleagues in School D. During Interview 3 she commented:

I was the only one from here .... Unless you have a group of teachers going I think you don't have that same enthusiasm. It's very hard to make a bit of an impact."(Debra, Interview 3, p. 6)

It is likely that Alan and Anne did not refer to the participation of other teachers from their school as a factor that influenced their professional growth because they were the only two teachers in School A who had not been involved in EMIC. This meant that they had support for the ideas presented in the program in their school, and they could easily seek assistance from, or share ideas with, other staff members at School A. In addition, Tanya (the EMIC tutor) was located at School A, so Alan and Anne had regular access to her support and ideas. It would seem from this particular example that the simultaneous participation of a group of teachers from the same school in a professional development program may not be necessary if certain conditions are evident in the school. These include: widespread knowledge of, and support for, the ideas presented in the professional development program; and active support and encouragement of individual teachers as they participate in the program.

During the tutor interview it became clear that Tanya considered the participation of groups of teachers to be a key structural feature of EMIC. She commented that a significant factor associated with how EMIC brought about change was "allowing teachers to change together" (Tutor Interview, p. 4). Tanya stated that she considered the opportunity to form collegial networks an important component of effective professional development.

I think ... that effective professional development programs allow time for teachers to talk amongst themselves and reflect on things. Teachers like to do that. They like it for lots of reasons. Apart from the fact that it gives them a chance to air their views, it also ... [allows them to] build up networks. And I know myself that has always been a great reason for going to inservices. Because you build up a network of friends and colleagues across the board, and teachers really need that. It helps you know where to go [for ideas and support]. (Tutor Interview, p. 8)
Tanya also felt that the responsibilities placed on participants during the program contributed to their professional growth. She considered the participants' responsibilities for sharing elements of their existing good practice, completing the professional readings included in the program, exploring new ideas in their classrooms, and reflecting on the outcomes of their classroom explorations to be important. Some teachers also inferred that they felt a responsibility to actively participate in the different components of the program. Structural features of the program associated with the participants' responsibilities are discussed in more detail in the sections below.

9.2.3 Sharing Ideas

All six teachers and the EMIC tutor commented on the importance of teachers having the opportunity to share ideas with one another during professional development programs. Alan, Beth and Debra reported that the sharing of ideas among teachers was something they valued in professional development activities they had been involved in prior to EMIC.

We've had some good ones [professional development activities] where teachers have shared their good ideas and activities and they were interesting. (Debra, Interview 1, p. 2)

An opportunity to talk about things and find out things outside of the school. ... There’s benefit in being able to sit there and talk and plan together. (Beth, Interview 1, p. 2)

Each of these teachers, along with Anne, Brian and Cath, commented on how they valued the planned opportunities for sharing ideas included in the EMIC program. These excerpts from Interviews 2 and 3 illustrate the teachers' views:

There were a lot of good ideas that came from the EMIC [participant] group. (Debra, Interview 2, p. 2)

I liked the participation of other schools and other teachers (and) showing things. (Cath, Interview 3, p. 7)

I was very impressed with the idea that each school each week shared ideas and things. I thought that was well run and very good. (Cath, Interview 3, p. 9)

One particular component of the EMIC program that the teachers seemed to value was called "This Works For Me". This involved teachers bringing to the EMIC sessions a good idea, activity or resource to share with the other participants. Many teachers
explored in their classrooms the ideas presented by other participants during this part of the program. For example Beth reported:

    I wanted to see how other people taught, to get ideas ... and through that "This Works For Me", that provided some things and I've used some of those [ideas and activities]. (Beth, Interview 2, p. 1)

Tanya also considered the sharing of teachers' ideas to be an important part of the program. In particular, she perceived the sharing of ideas to have benefits for teacher confidence and motivation. During the tutor interview she stated:

    That part of the program, "This Works For Me", I felt it impressed people a great deal, and I know it did me. I found that ... gave teachers great confidence that they were doing things right but there were other things they could [also] do. And that in itself was a key element—not throwing the baby out with the bath water, keeping the old and true and tried, and then bringing into that some elements of the new. (Tutor Interview, p. 3)

9.2.4 Experimentation and reflection

While it was obvious that all of the teachers engaged in classroom experimentation and reflection across the time of the study (see for example, Chapters 6 and 7), few spoke explicitly of these areas during interviews and informal discussions. Only three teachers, Alan, Beth and Cath made explicit comments with respect to experimentation and reflection. Their comments suggested the importance of teachers being encouraged to explore in their classrooms ideas presented during professional development programs, and to reflect on those explorations. Beth's comment, previously cited, highlights this:

    The format of EMIC and how it works over a period of time and asking people to go back to their classrooms and try it, and share [reflect] ... is the only way to do it. (Beth, Interview 3, p. 6)

Tanya considered that the requirement for teachers to explore ideas in their classrooms and to reflect on those explorations during subsequent EMIC sessions contributed to their professional growth. She reported that she felt the "Classroom Explorations" component of EMIC worked well because of the choice of activities available for teachers to explore.

    Activities between sessions I think is a wonderful idea. Particularly that there is a choice, that you don't all have to do the same things. So that people can adapt them to their own circumstances .... I think if you don't have those between unit activities that people forget between units what went on .... It [classroom exploration] is a great thing. (Tutor Interview, p. 8)
Tanya felt that the provision of time for teachers to reflect on their teaching practice was a characteristic of the EMIC program that encouraged teacher growth.

A key element ... is this reflecting on your teaching style and children's learning styles. The great thing a program like EMIC does is it actually allows teachers time to sit with a lot of other teachers and talk ... [for example, about] how I teach maths or how my children learn maths. (Tutor Interview, p. 4)

She considered planned opportunities for reflection to be a criterion for effective professional development.

I think that ... effective professional development programs allow time for teachers to ... reflect on things. (Tutor Interview, p. 8).

As reported in Chapters 6 and 7, it appeared that for all of the teachers involved in this study, their active involvement in completing classroom explorations, and in reflecting on those explorations, appeared to directly influence their professional growth. However, few teachers explicitly linked this activity with growth.

9.2.5 Support

The teachers and tutor referred to two main forms of support influencing teacher growth. These were collegial support and support from the program tutor. The structural design of the EMIC program included specific provisions for these support types. A further support type was referred to by the tutor. This related to the provision of school and system level support for participants.

The structural components of professional development related to collegial support were discussed in Section 9.2.2.

The provision of support for participants from the EMIC program tutor was a characteristic that obviously influenced the professional growth of some teachers. As part of her role, the tutor provided support for teachers during and between the EMIC sessions. The tutor provided support in the form of modelling teaching and learning processes, providing encouragement and feedback, and providing advice. During EMIC sessions she did this through demonstrating activities and responding to participants' comments and questions. Between EMIC sessions she did this through conducting school visits, meetings, and phone conversations with participants. In some cases, the tutor also provided support in the form of additional professional development activities.
Four teachers, Alan, Anne, Beth and Debra, reported that they valued the support the tutor provided, and Tanya herself considered her support role critical to the professional development process. Particular factors associated with the support role of the tutor are reported in Section 9.4.3.

Tanya also suggested that school and system level support can influence teacher professional growth. Referring to professional development in general, she noted the importance of formal recognition for participation in professional development programs, the need for support for professional development activities from school administrators, and the need for adequate funds to support professional development programs.

9.2.6 Resources

It appeared that most of the teachers valued the written materials that were provided in the EMIC program. Four teachers, Alan, Beth, Brian and Cath made specific mention of the EMIC Participant's Logbook (Ministry of Education, 1990a) as a useful resource. Each of these teachers reported using the logbook through to the period 10–12 months after the EMIC program. For example, Brian and Cath made these comments:

> Every couple of weeks I look through the folder and see what did we do that I thought was so good at the time. And I've done some of the activities from that folder. Yes, I reckon every couple of weeks I'd look it up. (Brian, Interview 3, p. 1)

> I like the idea that we keep the folder and can refer to it. (Cath, Interview 3, p. 9)

Tanya emphasised the value in having a professionally produced resource book for teachers involved in professional development.

> The provision of some sort of resource folder [is important]. ... Something they can take away and then find again .... Something put together professionally and properly at the beginning ... a resource that teachers can keep. (Tutor Interview, p. 8)

Tanya also commented on the professional readings provided in the EMIC program. She considered that while the inclusion of such readings was necessary and worthwhile, there should not be so many that teachers are unable to read them in the time available between sessions.

> I think a small amount of reading, not a huge amount of reading. One of the things that “killed” ELIC [Early Literacy Inservice Course]
and CLIP [Continuing Literacy Inservice Program] I think, was the huge amount of reading. Just a terrible amount of reading. It was so hard to keep up with that. And when there’s not just reading but there’s actual activities to try, it’s a lot easier. I don’t think teachers mind doing a little bit of reading, but sometimes four or five articles between a unit is, well, it’s inevitable that teachers are not going to do it ....

(Tutor Interview, p. 8)

9.3 Program content

This section describes factors associated with the content of professional development programs that the teachers and tutor viewed as important to teacher growth. Table 9.2 displays an overview of these factors. The factors have been grouped into two areas associated with content. These are: orientation and knowledge. Each of these is discussed below.

9.3.1 Orientation

The orientation of professional development programs with respect to the inclusion of practical ideas, together with recognition of the theoretical underpinnings of, and the affective response to, the ideas, is an area that concerns those responsible for the design and delivery of professional development as well as participants. In this study four teachers and the EMIC tutor made specific comments about this area.

Beth, Cath and Debra emphasised a preference for professional development activities that provide practical ideas. Cath reported her awareness of the need for new teaching ideas to be based on theoretical understandings. However, in the context of professional development programs, she felt that it was important to contextualise theoretical components in practical examples. The following comments made by Cath emphasise this point.

I must say of all the things I have attended I think it is perhaps the most worthwhile thing that I have done. For one main reason—it was practical. Something that you could use and do with a class. It was meaningful, it was practically based ....

(Cath, Interview 3, p. 7)

That was what I liked in EMIC too, there was a lot of doing, not just theorising. Because I think once you’ve done something then comes a bit more theory and you can understand and appreciate the theory then a bit more because you’ve done something and you’ve got an example. (Cath, Interview 3, p. 8)
Table 9.2
Overview of Factors Associated With the Content of Professional Development Programs Perceived by the Teachers and Tutor to Influence Growth (relevant teacher and tutor names listed in parentheses)

<table>
<thead>
<tr>
<th>AREAS ASSOCIATED WITH CONTENT</th>
<th>PROFESSIONAL DEVELOPMENT IN GENERAL</th>
<th>FEATURES OF EMIC PERCEIVED TO INFLUENCE GROWTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORIENTATION</td>
<td>professional development activities should be practical (Beth, Cath, Debra, Tanya)</td>
<td>presented practical ideas (Cath, Tanya)</td>
</tr>
<tr>
<td></td>
<td>participants should be actively involved in professional development sessions i.e. workshop style (Cath, Tanya)</td>
<td>involved participants actively in sessions i.e. workshop style (Beth, Cath, Tanya)</td>
</tr>
<tr>
<td></td>
<td>professional development should include theory (Tanya)</td>
<td>provided theoretical content (Tanya)</td>
</tr>
<tr>
<td></td>
<td>professional development should provide stimulating/inspiring ideas (Cath)</td>
<td>provided stimulating/invigorating/inspiring ideas (Brian, Cath, Tanya)</td>
</tr>
<tr>
<td></td>
<td>professional development should provide ideas to make teaching interesting (Debra)</td>
<td>provided interesting ideas (Debra, Tanya)</td>
</tr>
<tr>
<td>KNOWLEDGE</td>
<td>professional development should provide new teaching ideas (Beth)</td>
<td>provided new ideas related to teaching strategies (Alan, Anne, Beth, Brian, Cath, Debra, Tanya)</td>
</tr>
<tr>
<td></td>
<td>professional development should provide specific information related to how to implement new ideas (Brian)</td>
<td>provided specific mathematics teaching activities to explore (Alan, Anne, Beth, Brian, Cath, Debra, Tanya)</td>
</tr>
<tr>
<td></td>
<td>provided new ideas related to resource use (Alan, Anne, Beth, Brian, Cath, Debra, Tanya)</td>
<td>provided new ideas related to resource use (Alan, Anne, Beth, Brian, Cath, Debra, Tanya)</td>
</tr>
<tr>
<td></td>
<td>provided new assessment ideas (Alan, Anne, Beth, Brian, Cath, Debra)</td>
<td>provided new assessment ideas (Alan, Anne, Beth, Brian, Cath, Debra)</td>
</tr>
</tbody>
</table>

I didn’t view it [EMIC] just as theory. That was one of the best things, the fact that it was doing, and hands on and activity based and cooperative based. (Cath, Interview 3, p. 8)

I was impressed with the content. The areas were relevant and meaningful. (Cath, Interview 3, p. 9)

Tanya articulated a preference for professional development that was essentially practical in nature. However, she also stated the need to explicitly include theoretical content. Tanya reported that while she made every effort to present the EMIC program in a practical manner, she also planned specific opportunities for participants to engage in discussions related to the theoretical underpinnings of the program.
Three teachers and the tutor suggested that certain affective elements associated with the content of professional development programs might influence teacher growth. Brian, Cath and Debra, and Tanya, mentioned particular affective elements they considered important.

During Interview 1 Debra referred to effective professional development activities that she had experienced as being interesting. She commented:

We’ve had some good ones [professional development activities] where teachers have shared their good ideas and activities and they were interesting. (Debra, Interview 1, p. 2)

She stated later in the study that she considered the EMIC program provided many interesting ideas.

Cath referred to the need for professional development to provide stimulating and inspiring ideas.

There was one [professional development activity] ... that was only a day that I was very impressed [with] because I found it inspirational. I think teachers can do with a bit of inspiration now and again. (Cath, Interview 1, p. 2)

During Interview 2 she reported that she felt the EMIC sessions she attended were stimulating.

The series of lectures [EMIC sessions] ... were quite stimulating and I got some very good ideas which I was hoping to get out of it. (Cath, Interview 2, p. 1)

Brian also remarked on the stimulus for professional growth that the EMIC program provided. He stated that the program was “of great value” because it “invigorated” his mathematics teaching (Brian, Interview 3, p. 7).

Tanya considered affective elements including inspiration and stimulation to be a critical part of her role as the EMIC tutor. Further details related to how she did this are presented in Section 9.4.

Alan and Anne made no comment with respect to the orientation of the EMIC program, or to that of other professional development programs. The reasons for this can only be conjectured. For example, it may be that these teachers felt the EMIC program was appropriately balanced with respect to its practical and theoretical disposition and so they did not feel a need to comment on this area. Another reason may be that they were focused on seeking practical ideas for use in their classrooms and therefore were not particularly concerned with the theoretical components of the
program (or at least, with discussing them). In any case it was clear that all of the teachers involved in this study valued the practical ideas that they obtained through their participation in EMIC (see for example Chapters 6 and 7).

9.3.2 Knowledge

Few references were made by the teachers or the tutor to the content of professional development programs in general. Only two teachers, Beth and Brian, referred to knowledge related areas. Beth stated that she considered that professional development had the capacity to inform teachers of new ideas and trends.

I think any professional development of any subject is of benefit because if people go there with the idea of looking for something, it does open your eyes to other ways of teaching, other people's ideas, new trends and ways of doing things. (Beth, Interview 3, p. 5)

Brian made a comment about his need for information specific to the implementation of new ideas. He felt that he knew about some new teaching ideas, but that he was unsure of how to implement them.

There's a lot of good ideas, but I struggle to implement them through lack of training. (Brian, Interview 1, p. 9)

All six teachers reported that EMIC provided them with knowledge of new ideas for teaching mathematics and specific mathematics teaching activities. Similarly all six teachers stated that they acquired knowledge of new ideas related to resource use and knowledge of new assessment ideas from the program. The teachers appeared to value this new knowledge as an important part of their professional growth. The following interview excerpts highlight this:

It [EMIC] made me realise that maths is really very different to what I thought it was, to what I always imagined it to be. It was the approach through EMIC. It was really good. (Alan, Interview 2, p. 1)

I felt that I gained a lot from it [EMIC] in regards to activities and confidence also. ... I think perhaps I have developed my ability to ... relate maths to real life situations more, in a deeper way and a better way. (Anne, Interview 2, p. 1)

I have more activities than I previously had in all areas of maths. And as I said before, a legitimisation that it's fine to do those things, they have got a place. ... It's made me feel better about it, offered me more resources and legitimised it. (Beth, Interview 3, p. 2)
Something that struck me when I heard it at EMIC ... is really calling for multiple approaches, multiple strategies, how did you get that answer? ... And I'm finding that there are millions of strategies that I didn't know existed. ... So that's been a big change and I'm happy about that. (Brian, Interview 3, p. 4)

It [EMIC] gave me some good ideas and it also I suppose broadened or made me more aware of some areas of maths that perhaps I hadn't done much on before. (Cath, Interview 2, p. 1)

I found it [EMIC] really beneficial ... I needed those ideas on what to do from Prep right through to Grade 6, so it was valuable there. And it was really interesting to see the range of resources available for teachers and to be exposed to those. (Debra, Interview 3, p. 8)

Tanya also noted the importance of the EMIC program providing teachers with new knowledge.

While the teachers and tutor in this study considered that the EMIC program provided new ideas related to the teaching and learning of mathematics, they made no references at all to mathematical content. They appeared to focus on what Shulman (1986, 1987) referred to as pedagogical-content knowledge, pedagogical knowledge and curricular knowledge to the exclusion of content knowledge. That is, they appeared to expect to learn new ideas and knowledge about the teaching and learning of mathematics, but not about the subject of mathematics itself. This is of particular interest given that other researchers have noted the impact of teachers' mathematical knowledge on their instruction (see for example, Ball, 1988; D.M. Clarke, 1994; Erickson, 1986; Fennema & Franke, 1992). It seems that there is a link between well developed and well organised content knowledge and "effective" teaching (D.M. Clarke, 1994; Fennema and Franke, 1992; Shulman, 1986). Brophy (1991) stated:

Where [teachers'] knowledge is more explicit, better connected, and more integrated, they will tend to teach the subject more dynamically, represent it in more varied ways, and encourage and respond to student comments and questions. Where their knowledge is limited, they will tend to depend on the text for content, de-emphasize interactive discourse in favor of seatwork assignments, and in general, portray the subject as a collection of static, factual knowledge. (p. 352)

This being the case, one might have expected the teachers and tutor to have articulated an interest in issues specifically related to content knowledge. However, it appeared that their interests aligned with the explicit pedagogical focus of the EMIC program. The teachers' and tutor's lack of attention to content knowledge is particularly noteworthy. It is also interesting to note that in Phase One of this study some of the
EMIC Developers expressed a concern related to the apparent lack of mathematical content in the EMIC program (see Section 4.4.2).

9.4 Program presentation

The teachers and tutor involved in this study made several comments related to the influence of the program presenter on teacher professional growth. However, they made no comments about the presenters of professional development generally. Their comments related directly to Tanya, the tutor who presented the EMIC course. Table 9.3 therefore displays characteristics specific to Tanya that the teachers and tutor referred to across the time of the study. These characteristics are discussed below.

9.4.1 Presentation style

The teachers and the tutor involved in this study made many comments about Tanya's effective presentation style (see Table 9.3). In particular, they identified a range of characteristics associated with her professional knowledge, her organisational abilities, and her personality.

With respect to professional knowledge, the teachers referred to Tanya's knowledge of mathematics teaching and learning, her knowledge of the professional development program, and her knowledge of adult learning styles. In particular, Cath reported that she appreciated Tanya's use of personal teaching anecdotes during EMIC sessions.

I found some of the anecdotes to her class so suitable to me. You know, I can just imagine it [them]. (Cath, Interview 3, p. 8)

In addition, Tanya suggested that important elements of her role included: using personal examples of teaching practice; acting as a role model for participants; actively involving participants in EMIC sessions; and addressing theoretical components of the program.

Two teachers, Anne and Cath, noted Tanya's effective organisational skills.

I think the way it was run was very professional. It was well planned. Each session was well planned. (Anne, Interview 3, p. 6)
Table 9.3  
Overview of Characteristics of the EMIC Tutor Perceived by the Teachers and Tutor to Influence Growth (relevant teacher and tutor names listed in parentheses)

<table>
<thead>
<tr>
<th>AREAS ASSOCIATED WITH THE PROGRAM PRESENTER</th>
<th>CHARACTERISTICS OF THE EMIC TUTOR PERCEIVED TO INFLUENCE GROWTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRESENTATION STYLE</td>
<td>• well organised and prepared (Anne, Cath, Tanya)</td>
</tr>
<tr>
<td></td>
<td>• created a positive and comfortable atmosphere (Alan, Anne, Tanya)</td>
</tr>
<tr>
<td></td>
<td>• demonstrated enthusiasm (Beth, Tanya)</td>
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<tr>
<td></td>
<td>• presented in a positive and interesting manner (Brian, Cath, Tanya)</td>
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<td></td>
<td>• demonstrated a sense of humour (Cath, Tanya)</td>
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<td></td>
<td>• was approachable (Cath, Debra, Tanya)</td>
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<td></td>
<td>• used personal teaching anecdotes (Cath, Tanya)</td>
</tr>
<tr>
<td></td>
<td>• provided supplementary ideas (Alan, Beth, Cath, Debra, Tanya)</td>
</tr>
<tr>
<td></td>
<td>• acted as a role model (Tanya)</td>
</tr>
<tr>
<td></td>
<td>• actively involved participants in sessions (Tanya)</td>
</tr>
<tr>
<td></td>
<td>• addressed theoretical issues (Tanya)</td>
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<tr>
<td>CREDIBILITY</td>
<td>• considered credible by teachers (Cath, Tanya)</td>
</tr>
<tr>
<td></td>
<td>• used own experiences and anecdotes (Cath, Tanya)</td>
</tr>
<tr>
<td></td>
<td>• well respected (Brian)</td>
</tr>
<tr>
<td></td>
<td>• classroom teacher (Tanya)</td>
</tr>
<tr>
<td></td>
<td>• presenter of many professional development activities (Tanya)</td>
</tr>
<tr>
<td>SUPPORT</td>
<td>• provided encouragement to participants (Alan)</td>
</tr>
<tr>
<td></td>
<td>• provided assistance to teachers (Alan, Anne, Beth, Debra, Tanya)</td>
</tr>
<tr>
<td></td>
<td>• provided time to support teachers (Debra, Tanya)</td>
</tr>
<tr>
<td></td>
<td>• keen to support teachers (Tanya)</td>
</tr>
<tr>
<td></td>
<td>• provided further professional development activities (Anne, Tanya)</td>
</tr>
</tbody>
</table>

I thought she did it [EMIC] with the right amount of organisation. Not too stilted, not so organised that ... no-one even had time for a laugh. (Cath, Interview 3, p. 8)

Tanya also suggested that it was important to her to be well prepared and organised.

All six teachers, as well as Tanya, made comments inferring the importance of Tanya’s personality. Particular characteristics they emphasised included: demonstrated enthusiasm; positive and interesting manner; demonstrated sense of humour;
approachability; and ability to create a positive and comfortable atmosphere. The following interview excerpts highlight some of these points.

Everyone was made to feel comfortable. ... Tanya encouraged everyone to participate. (Alan, Interview 2, p. 5)

I must say that the program I attended was an excellent program. I felt that the people there participated well and were enthusiastic, especially the tutor. I have been on an ELIC [course] and it was very, very boring ... it's not remembered with enjoyment or anything. And I think that's a key element. (Beth, Interview 3, p. 5)

I thought she [Tanya] was excellent. I thought actually as a lecturer she was really good because I liked her approach, she was down to earth, she didn't put her knowledge up as being superior ... I feel that she presented with a good sense of humour which I think is important. (Cath, Interview 2, p. 7)

I never expected it [EMIC] to be that good! ... I'd promote it. I'd do an ad for it. But I think you need to look really carefully at the person taking it. I think everyone enjoyed it. A lot of it was Tanya's personality. ... Although it's the same course all over, a lot of people say it can be horrible. (Brian, Interview 3, p. 8)

My style as an EMIC tutor was, I think, rather relaxed. I liked to be kind of entertaining and humorous if I could be, and somehow I think I established myself as having a reputation for being like that. (Tutor Interview, p. 1)

The teachers, and Tanya, suggested that her presentation style had a direct impact on the success of the EMIC course she conducted, and on the professional growth of some teachers. As noted by Brian:

She [Tanya] made it. She was excellent. (Brian, Interview 2, p. 6)

### 9.4.2 Credibility

Two teachers, Brian and Cath, made reference to Tanya’s credibility as a professional development presenter. Brian and Cath both reported that Tanya was considered credible, and was well respected by EMIC participants.

I can see after having Tanya, she really made the course great, that if you had someone that you didn't really respect then you wouldn't want to do the course. (Brian, Interview 3, p. 6)

The importance of the tutor's credibility was highlighted by Brian during an informal discussion in the year following his participation in EMIC. Brian, who had moved to a new school, School Z, reported that teachers in that school were not keen to participate in EMIC because they did not respect the tutor responsible for conducting
courses in their district (Brian, Fieldnotes, Observation 5). In this case, it appeared that the lack of credibility of the tutor was an impediment to teacher professional growth for some teachers at School Z and surrounding schools.

Tanya considered that she gained credibility through her role as a full-time classroom teacher, and her role as a presenter of many professional development activities in her school district, and in other districts.

I had a great deal of credibility because I was a classroom teacher. ... I used to build on that a lot by doing all the between unit activities and activities that were part of the workshop with my own kids and bringing samples of their work. Also I used my staff at every school I was at, and used their samples of work ... to sort of enhance the program for my participants. (Tutor Interview, p. 2)

I had some credibility as someone who sometimes presented at maths conferences and at various things. (Tutor Interview, p. 2)

I was quite well known in Family Maths and I had done Families Count and things, so I would bring in things from other programs and show how they could also be adapted and used in the classroom. (Tutor Interview, p. 2)

Tanya stated that tutors who were classroom teachers had an "enormous amount of credibility" (Tutor Interview, p. 1). The use of full-time classroom teachers as professional development presenters was a feature of many Victorian professional development programs at the time when this study was conducted. In particular, the majority of EMIC tutors were full-time classroom teachers

9.4.3 Support

Tanya regarded her support role as critical to the professional growth of the teachers she worked with. She felt that she could identify with the needs of teachers and she appeared to want to provide the kinds of support that she herself would value.

I put my support role into, well I sort of understood it I think, because as a classroom teacher I know how hard it is to do things that are required from outside, particularly when your school might have some sort of program that you are involved in going at the same time as you're doing EMIC. (Tutor Interview, p. 1)

I was very keen to support people in their schools. I always allowed myself time to visit every teacher in their classroom or to offer them the alternative of coming to my classroom, and either helping or trying something out with my kids or seeing my kids do things. I found often people wanted you to go into their room and run something they found a bit hard. I was always quite happy to do that. (Tutor Interview, p. 2)
It appeared that Tanya's enthusiasm for supporting teachers was warmly received by them. Four teachers, Alan, Anne, Beth and Debra stated that they appreciated her assistance and support.

My biggest resource is having Tanya in the school. (Alan, Interview 2, p. 3)

I think people [our staff] ... have learnt a lot from Tanya. I mean, she's got a lot to give. ... She really puts in and tries to help. (Alan, Interview 2, p. 4)

She was always open to any questions we had. There was always time given. (Debra, Interview 2, p. 7)

I know there's that ongoing thing that I can always refer back to Tanya and get her in for a lesson. I guess it's sort of broken down some barriers for me having come back into a school situation and knowing who to go to for maths has helped. (Debra, Interview 2, p. 1)

While Brian and Cath did not specifically mention the support Tanya provided, it was obvious that they were aware of how to access her support, and that they appreciated her willingness and availability to support program participants.

9.5 Relationships between the findings of this study and the existing literature

The research literature related to conditions supportive of teacher change and associated characteristics of effective professional development was examined in Section 2.1.3. This section comments on the relationships between the views of the teachers and tutor in this study and key points highlighted in the literature.

9.5.1 Overview of similarities in the findings of this study and the existing literature

Table 9.4 provides a broad overview of the characteristics of effective professional development that were both evident in the research literature and in the data collected in this study. The left-hand column of the table displays a summary of characteristics of effective professional development that were evident in the literature. This summary
Table 9.4

Links Between the Findings of this Study and the Research Literature With Respect To Characteristics of Effective Professional Development Programs

<table>
<thead>
<tr>
<th>CHARACTERISTICS OF EFFECTIVE PROFESSIONAL DEVELOPMENT [see Table 2.4]</th>
<th>RELATED DISCUSSION IN THIS CHAPTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>• is developmental</td>
<td>• Duration (9.2.1)</td>
</tr>
<tr>
<td>• takes place over extended periods of time</td>
<td></td>
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<tr>
<td>• involves staff commitment to follow through</td>
<td></td>
</tr>
<tr>
<td>• addresses issues of concern and interest recognised by teachers</td>
<td>• Orientation (9.3.1)</td>
</tr>
<tr>
<td>• optimises work-embedded learning opportunities</td>
<td>• Knowledge (9.3.2)</td>
</tr>
<tr>
<td>• encourages participation</td>
<td>• Experimentation and reflection (9.2.4)</td>
</tr>
<tr>
<td>• encourages analyses</td>
<td>• Sharing ideas (9.2.3)</td>
</tr>
<tr>
<td>• encourages reflection</td>
<td></td>
</tr>
<tr>
<td>• encourages collegiality</td>
<td>• Experimentation and reflection (9.2.4)</td>
</tr>
<tr>
<td>• provides opportunities for ongoing support from colleagues, consultants and/or critical friends</td>
<td>• Orientation (9.3.1)</td>
</tr>
<tr>
<td>• employs cooperative and collaborative practices</td>
<td>• Support (9.2.5)</td>
</tr>
<tr>
<td>• encourages substantial teacher ownership of change implementation</td>
<td>• Participation (9.2.2)</td>
</tr>
<tr>
<td>• regards teachers as partners in the change process</td>
<td>• Orientation (9.3.1)</td>
</tr>
<tr>
<td>• is embedded into the ongoing work of the school</td>
<td>• Participation (9.2.2)</td>
</tr>
<tr>
<td>• integrates individual and organisational development</td>
<td>• Support (9.2.5)</td>
</tr>
</tbody>
</table>

was previously presented in Table 2.4 (see page 29). The right-hand column of Table 9.4 highlights the particular sections in this chapter in which the teachers' and tutor's views related to these characteristics are discussed.

Importantly, the teachers and tutor in this study reported some additional characteristics of effective professional development programs that were given little prominence in the research literature. These characteristics are discussed below.
9.5.2 Characteristics given little prominence in the literature

The teachers and tutor in this study emphasised two characteristics of effective professional development programs that are not widely discussed in the research literature. They noted the value in providing teachers with specific professional development program resources, and they reported the role of the program presenter to be critical to professional development program success.

*Professional development program resources*

The teachers and tutor considered the written materials provided in the EMIC program useful. Several teachers referred to the EMIC Participant's Logbook (Ministry of Education, 1990a) for ideas and information following their involvement in EMIC.

The provision of professional materials such as participant logbooks is not often cited in the literature as an essential component of effective professional development programs. However, some researchers have noted the importance of providing teachers with innovative curriculum materials. For example, in his study of two middle-grade teachers use of innovative mathematics curriculum units in the United States, D.M. Clarke (1997) found that:

> Providing curriculum units with an understanding that teachers are free to adapt these units to meet the needs of their students may be both more effective and more efficient than expecting teachers to create such units "from scratch". (p. 300)

It seemed that the teachers in this study appreciated and made use of the ideas presented in EMIC in similar ways to the ways in which teachers in D.M. Clarke's study made use of particular curriculum units that were provided for them. The teachers explored specific activities provided in the EMIC Participant's Logbook, both during the course, and following it. The extended use by participants of the EMIC Participant's Logbook was intended by the program developers. As noted on the first page of the logbook:

> It is a resource for participants during and after the ten week program. (Ministry of Education, 1990a)

The effect on the professional growth of the teachers in this study had they not been provided with a participant's logbook can only be the subject of conjecture. However, what can be stated is that most teachers appeared to refer to the written materials for an extended period beyond the completion of the EMIC course, and they considered them useful.
The role of the program presenter

The teachers and tutor reported that the way in which professional development programs are presented can significantly influence teacher professional growth. In particular, they suggested that a presenter's style, credibility and ability to provide appropriate forms of support, can influence whether teachers accept or reject professional development program ideas.

The notion of program presentation is particularly important considering that it is essentially through program presenters that professional development program content is communicated. It is the medium of "the presenter" that distinguishes professional development programs from other forms of professional development activity (such as written self-paced manuals, collegial discussions and observations, and independent action research). However, as highlighted in Chapter 2, few references are made to the significant role of the program presenter in the literature related to effective professional development.

Interestingly, in Phase One of this study, the EMIC Developers emphasised the importance of the program tutor's role (see Section 4.4.3). Many of the EMIC Developers suggested that the tutors played a critical role in the program's success. The strong emphasis placed on the importance of the EMIC Tutor's role by the program participants in this study, and the EMIC Developers, suggests this is an area worthy of further investigation with respect to possible influences on teacher professional growth.

9.6 Factors associated with mathematics professional development programs perceived as influencing growth

The specific research question that focused the data gathering and the analysis reported in this chapter was: what factors associated with mathematics professional development programs do teachers perceive as influencing growth? This section summarises the findings associated with this research question.

The teachers and tutor perceived factors associated with three broad areas of professional development programs as influencing growth. These areas related to the structure, content and presentation of professional development programs.
With respect to the structure of professional development programs, the teachers and tutor perceived important factors to be:

- the extended duration of programs—long term programs were considered to be most beneficial;
- the participation of groups of teachers—collegiality was considered important in encouraging and supporting individual teacher growth;
- the inclusion of opportunities for teachers to share experiences and ideas;
- the inclusion of structured opportunities for teachers to explore program ideas in their classrooms and to reflect on their classroom practice;
- the provision of regular support from program facilitators; and
- the provision of professional development program resources.

The teachers and tutor considered important factors associated with the content of professional development programs to be:

- the inclusion of both practical ideas and theoretical content;
- the active involvement of participants in sessions;
- the provision of interesting and stimulating ideas; and
- the provision of new teaching ideas.

With respect to the presentation of professional development programs, the teachers and tutor perceived important factors to be:

- the style of the presenter—including organisational abilities, enthusiasm, interest, and approachability;
- the credibility of the presenter; and
- the ability of the presenter to provide appropriate support to program participants.

There was a high level of consistency between these factors perceived by the teachers and tutor as influencing growth, and those highlighted in the research literature (see Section 9.5.1). There were no "new" factors reported by the teachers and tutor, although two that had been given little prominence in the literature were the provision of professional development program resources and the role of the program presenter (see Section 9.5.2).

The consistency between the factors listed above and those identified in the literature is not altogether surprising given that the literature represents many studies of teacher professional growth and professional development programs, and that the EMIC program was selected to act as the vehicle to examine teacher growth in this study because it possessed many of the characteristics of effective professional development
programs grounded in the literature. However, the findings of this study suggest that an area worthy of further investigation is the important role played by the presenters of professional development programs in teachers' professional growth.

The influence of the program presenter's role on teacher growth was noted in this study by the teachers and tutor (see Section 9.4) and by the EMIC Developers (see Section 4.4.3). Each of these groups acknowledged that program presenters could positively encourage or impede teacher growth. They suggested that program presenters can have a substantial impact on the overall effectiveness of (even the best) professional development programs. These findings have implications for those responsible for selecting and training presenters. In particular, it would seem that the careful selection and training of presenters is critical to encouraging and supporting teacher professional growth in the context of professional development programs.

The teachers and tutor in this study made many comments that emphasised positive characteristics of program presenters—in particular, with respect to program presenters' presentation styles, their credibility, and their ability to provide appropriate support to program participants. It is anticipated that the characteristics of effective program presenters identified in this study (which are listed in Table 9.3) could usefully inform processes of selecting and training program presenters in other contexts. For example, the use of full-time classroom teachers as professional development presenters might well be explored in other contexts.

In the next chapter, the findings associated with the major research question that guided this study are interpreted and discussed.
Chapter 10
Professional development programs as vehicles for effecting the professional growth of teachers of primary mathematics

In this chapter, the findings of this study are interpreted and discussed with respect to the major research question: can professional development programs act as appropriate vehicles for effecting the professional growth of teachers of primary mathematics? The discussion is presented in two main sections. The first section discusses the extent to which EMIC acted as an appropriate vehicle for effecting the professional growth of teachers of primary mathematics—with respect to the teachers in this study, and teachers more generally. The second section discusses the extent to which the findings of this study can inform how professional development programs, more generally, might act as appropriate vehicles for effecting the professional growth of teachers of primary mathematics.

The conclusions and recommendations of this study are presented in Chapter 11.

10.1 EMIC as an appropriate vehicle for effecting the professional growth of teachers of primary mathematics

The data collected in this study provide evidence that the EMIC program provided one means for the effective professional development of teachers of primary mathematics. It was able to act as a vehicle for the professional growth of teachers with respect to the teaching of mathematics.

This section describes: the effects of EMIC on the teachers in this study; findings related to the individualistic nature of teacher change and growth; findings related to the way in which the outcomes that teachers report and demonstrate reflect the content of the professional development program; and key elements of the EMIC program with respect to effecting teacher professional growth.
10.1.1 The effects of EMIC on teacher professional growth

In this study, teacher professional growth was viewed through the goals of the EMIC program. Therefore growth was interpreted in terms of the aims of the program. In particular, growth, as it was defined in this study, related only to those lasting changes in practice or beliefs associated with teachers’ “adoption” of the ideas presented in EMIC (see Section 5.3.2).

Although there were differences between teachers, the program studied can be seen as successful with respect to the stated aims of EMIC (see Section 3.2.3) as it resulted in teachers:

- reflecting on their mathematics teaching;
- developing pedagogical content knowledge;
- engaging in classroom experimentation;
- working cooperatively together; and
- developing confidence.

However, it is of interest that the teachers did not report or demonstrate growth with respect to one of the program’s stated aims, which was to explore the role of parents in supporting children’s mathematics development (see Section 8.1.1).

It is important to note that the aims of EMIC were stated almost exclusively in terms of actions in which teachers would engage (for example, experimenting and reflecting) rather than the outcomes of these actions. The data in this study provided evidence of teachers’ engagement in these actions, and of outcomes associated with these actions. In particular, it provided evidence of enduring changes in teachers’ classroom practice, and in their knowledge, beliefs and attitudes (see Chapters 6, 7 and 8).

Importantly, the EMIC program had some effects on teacher professional growth in areas not identified in the statement of aims. First, it appeared that the EMIC program positively affected teachers’ “professional self-esteem” with respect to teaching mathematics—in particular, most teachers developed more positive attitudes towards mathematics teaching. This is an area that appears to have been given little emphasis in the literature related to teacher change and mathematics education. Yet it may have a significant effect on teachers’ preparedness and ability to change. The notion of professional self-esteem and its effect on professional growth is an area worthy of further investigation.
Second, the EMIC program appeared to play a significant role in "institutionalising professionalism" in the primary education community with respect to mathematics teaching. Across the time of this study, the EMIC program developed a high profile among teachers in schools as an essential professional development activity in which to be involved. For many primary teachers, mathematics became a focus for their professional growth. The following comments, made by the EMIC tutor in this study, highlight the attitude that prevailed in the primary education community with respect to the significant effect of EMIC on teachers and schools:

> It became, in Victoria, certainly the key word for maths that was good. (Tutor Interview, p. 4)

> You can see, perhaps not immediately, but certainly years later, just how effective some professional development programs have been—EMIC being a very good example of this. I mean if you were to look two or three years down the track at the effect of a professional development program that was as widely accepted as say EMIC was, you can see, have the key elements of the program become accepted elements of teaching practice in Victoria? Well, they have. You see elements of EMIC in every school in Victoria, you really do. (Tutor Interview, p. 9)

In brief, it can be claimed that the EMIC course examined in this study did act as a vehicle for teacher professional growth in terms of its own aims, but also beyond them. However, as has become evident throughout the study, there was significant variation in the impact of the program on the different teachers studied.

### 10.1.2 The individualistic nature of change and growth

As in some other studies of teacher growth and professional development (see, for example, D.M. Clarke, 1997), the teachers in this study experienced the same professional development program, however they demonstrated and reported different outcomes (see Chapter 8). One finding from the analysis of the data is the need to acknowledge teachers' individual differences when considering the effects of professional development programs. In particular, it appears that teachers' experience, knowledge, beliefs, attitudes and practices upon entering a professional development program will effect what they learn or achieve through participating in the program. The outcomes of professional development programs will therefore be shaped by individual teacher's needs, capabilities and interests.
The EMIC program had several design features that appeared to cater for individual teacher differences. For example, teachers were afforded choices with respect to the kinds of activities and ideas they explored in their classrooms, and therefore to the ideas they might adopt or adapt as part of their ongoing mathematics teaching practice. In addition, they were able to direct discussions during "sharing", "reflection", and "question" times towards their needs and interests. Similarly, teachers could seek those forms of support and assistance from the program tutor that best suited their personal needs. Each of these design features enabled teachers of varying backgrounds, and current school contexts, to participate effectively in the same professional development program. Those responsible for the design and implementation of teacher professional development might well consider including design features such as these in programs.

However it is necessary to first ask the extent to which it is a desired outcome that a professional development program effects individual teachers differently. At a systemic level, it might seem appropriate that the goals of professional development be directed towards encouraging teachers to work in similar ways—for example, ways that take into account current recommended practices. However, recognising that teachers have different experience, knowledge, beliefs, attitudes and practices, it would be naive to assume that they would have the same professional development needs or that through participating in professional development they would develop in the same ways. Many current approaches to professional development adopt a learning perspective on teacher change (see D.J. Clarke & Hollingsworth, 1994) where "difference" between teachers is both anticipated and planned for. Such approaches do not explicitly encourage teachers to demonstrate different outcomes but rather seek to provide opportunities for all teachers to develop. Goldsmith and Schifter (1997) suggest that "development ... presumes progressive movement toward a goal" (p.21). It seems that an appropriate aim for a professional development program is to encourage all teachers to develop in positive ways towards its goals.

10.1.3 Program outcomes reflect program content

The data collected in this study provided evidence of the strong link between the content and outcomes of professional development programs. In particular, the outcomes reported and demonstrated by the teachers reflected the content of the EMIC program—that is, the teachers reported and demonstrated a strong focus on pedagogical issues.
A strong pedagogical focus

Across the time of the study the teachers referred consistently to changes related to their teaching of mathematics—in particular, they focused on the practicalities associated with their changed practice. However, significantly, they made little mention of mathematics subject matter, student learning outcomes, or other outcomes associated with their changed practice (see Chapter 8).

The teachers' strong focus on the practicalities associated with their changed practice was reflected in the significant number of growth networks of the kind displayed in Figure 10.1 that were evident in representing the teachers' growth across the time of the study (see Chapters 6, 7, and 8).

![Diagram](image)

*Figure 10.1. Growth network frequently evident when representing teachers' growth.*

There are a number of possible reasons why the teachers might have attended to practical aspects associated with changing their practice more than outcomes. One possible reason relates to the design and content of the EMIC program. As reported in Chapter 8, some obvious links existed between strategies and ideas explored by all or most of the teachers, and the kinds of strategies and ideas emphasised in the EMIC program (see Section 8.1). The strong focus in EMIC on discussing pedagogical issues is likely to have had a direct influence on teachers. While outcomes of teachers' classroom experimentation were considered in the program, it is probable that greater attention was given to the practicalities associated with teachers' changed practices.

Another possible reason why the teachers might have attended to practical aspects associated with changing their practice more than outcomes is that they may have postponed the consideration of outcomes until they felt they had achieved proficiency in their new practices—that is, until they had "perfected their new practices". Their initial priority may have been to attend to, and reflect on, practical aspects to ensure
that they “got it right” and then later focus on outcomes. The strong predilection for “getting it right” might be related to the context within which teachers work. Schools often value a climate of order and control more than learning (Goodlad, 1983). Teachers who had experienced such a school climate might feel compelled to get things right (as soon as possible and with little regard for learning) to maintain an ethos of control and order.

A further reason may be that the teachers’ preoccupation with practicalities rather than outcomes is part of their regular modus operandi. Teachers often focus on the practicalities of their day-to-day teaching rather than the actual outcomes of their teaching. For example, they appear to give much attention to how particular lessons are going to work, and then judge the success of the lessons according to whether or not they worked well (from an organisational perspective, for instance), rather than the kinds and amount of student learning that occurred. It may be that teachers are predisposed to accepting ideas presented in professional development programs as “good” because of their endorsed status. Teachers might simply “trust” that there are positive outcomes associated with these good ideas, rather than assessing outcomes themselves.

A lack of reference to mathematics

During this study the teachers made little or no reference to mathematics. This is of interest given that this was a study of professional growth for teachers involved in mathematics professional development, and that there is evidence in the research literature of links between teachers’ mathematical content knowledge and their effectiveness as teachers of mathematics (see for example, D.M. Clarke, 1997; Shulman, 1986). It seemed reasonable to anticipate that the teachers might have discussed issues associated with content knowledge, pedagogical content knowledge, curricular knowledge, and pedagogical knowledge (Shulman, 1986, 1987), and the extent to which the professional development program supported or neglected their development of knowledge in these areas. However, while teachers made many comments related to pedagogical content knowledge and pedagogical knowledge, and a few that related to curricular knowledge, they made no comments related specifically to mathematics content knowledge.

The absence of teacher comment associated with mathematics content knowledge might be attributed to at least three factors. These are:
• the teachers did not consider mathematics content knowledge to be important;
• although the teachers considered mathematics content knowledge important, they did not have the opportunity, or perhaps feel any obligation, to discuss it during the study; and
• although the teachers considered mathematics content knowledge important, they did not have a discourse available to use to discuss it.

A number of questions arise from a consideration of these factors.

*Is the lack of emphasis on mathematics content knowledge a methodological anomaly?*

During the interviews conducted in this study teachers were not asked specific questions related to their mathematics content knowledge. However, they did have the opportunity to speak about mathematics, and their knowledge of mathematics, on many occasions. Therefore it is unlikely that the lack of emphasis on mathematics was entirely a methodological anomaly.

*Is the lack of emphasis on mathematics content knowledge a characteristic specifically associated with the EMIC professional development program?*

As reported in Chapter 3, the EMIC program focused on pedagogy. While some issues related to teachers’ mathematical content knowledge were considered in the program, it essentially encouraged teachers to explore and consider adopting new methods for teaching mathematics. It is of interest to note that some program developers expressed concern about the lack of explicit mathematical content in EMIC (see Section 4.4.2).

*Does the lack of emphasis on mathematics content knowledge with respect to teacher professional development reflect the values of the mathematics education community at the time when this study was conducted?*

It is interesting to consider whether there was a predisposition to focus mathematics professional development efforts on developing teachers’ pedagogical content knowledge, pedagogical knowledge, and curricular knowledge, rather than their content knowledge during the period when this study was conducted. The climate of change that was evident during the 1980s and early 1990s saw significant changes recommended with respect to the teaching of mathematics and to curriculum programs (see for example, Section 2.2.1). It might be that teachers regarded the pedagogical and curriculum changes professionally confronting and challenging, and therefore requiring more immediate attention than issues related to mathematical content knowledge.
Is the apparent lack of emphasis on mathematics content knowledge a primary teacher phenomenon?

Three important issues arise in considering this question: primary teachers may not be aware of mathematics content knowledge inadequacies; they may lack a discourse for articulating their concerns or ideas about specific mathematics content; they may lack a "history of practice" with respect to focusing specifically on mathematics content issues—they may be uncomfortable in discussing issues related to mathematics content, or they may consider content issues to be inextricably linked with pedagogical issues and therefore not distinguish between them.

Implications

The obvious focus of teachers in this study on pedagogical issues, to the exclusion of content issues, raises several questions with respect to the purpose, goals and design of EMIC and other professional development programs. For example:

- can the EMIC program be seen as effective given that it did not effect teacher growth in content knowledge?
- is it appropriate for mathematics professional development programs not to effect teacher growth in content knowledge given that there is evidence in the research literature linking strong mathematical content knowledge with teaching effectiveness? and
- is it possible, or even desirable, for professional development programs to attempt to address all teacher knowledge areas?

As suggested in Section 10.1.1, the EMIC program was considered to be effective with respect to achieving its aims. The program focused on developing teachers' pedagogical content knowledge and it appeared successful in doing that. Considering the large commitment in terms of time and resources that were already invested in the program, it is questionable whether any additional content could have been included in the program. Moreover, considering the positive response of participants to the existing program, it is not obvious what parts of the program should be excluded if the program were to be redesigned to include a stronger mathematical focus.

Given the evidence in the research literature linking teachers' mathematical content knowledge with teaching effectiveness it would seem appropriate to suggest that professional development programs attempt to effect growth in this area. However, as evidenced in this study, there is value, on occasions, in primary teachers focusing specifically on areas associated with pedagogy. What seems critical is establishing a
comprehensive approach to teacher professional growth in mathematics—one that includes opportunities for developing teachers’ content knowledge as well as other knowledge areas. For example, it may be necessary for teachers involved in programs like EMIC to also be involved in other forms of professional activity in which they can develop mathematics content knowledge.

With respect to the possibility and desirability of professional development programs addressing all teacher knowledge areas, it would seem that this would depend on the purpose and goals of the programs (including the needs of the school system) and, in particular, the anticipated needs and interests of the teacher audiences. While it may be possible to attend to several areas of teacher knowledge in one program, the breadth of content that can be covered may be limited by available time and resources. Depending on a range of professional and personal factors, this may suit the purposes of some teachers but not others.

Because the content of professional development programs appears to be reflected in the program outcomes teachers report and demonstrate, it seems crucial that those responsible for the design and implementation of professional development programs thoughtfully consider their purposes and goals. It also seems imperative that teachers engage in comprehensive mathematics professional development which encourages growth in different areas.

10.1.4 Key elements of EMIC with respect to effecting the professional growth of teachers of primary mathematics

The key elements central to the success of the EMIC program with respect to effecting teacher professional growth, can be summarised as:

- **its extended nature**—the EMIC program consisted of ten 2-hour workshops which were conducted either weekly or fortnightly, thus providing opportunities for teachers to further explore program ideas between workshops;

- **its consistent format**—EMIC comprised a series of workshops with a common structural design;

- **its pedagogical orientation**—the EMIC program primarily focused on issues associated with the teaching and learning of mathematics;

- **its explicit inclusion of structured classroom experimentation**—a specific component of EMIC involved teachers in exploring in their classrooms program ideas;
• its explicit attention to teacher reflection on classroom practice—a specific component of the program encouraged teachers to reflect on their practice;
• its presentation by "qualified" program tutors—EMIC programs were conducted by teachers or consultants who had themselves participated in intensive professional development and program training; and
• its provision of ongoing participant support—EMIC tutors were responsible not only for the delivery of the program but also for the ongoing support of teachers in their schools throughout the duration of the program.
(See Chapter 9).

As reported in Chapter 9, many of these elements are similar to those identified in the research literature as characteristics of effective professional development. While these broad program elements can be seen to be directly associated with the success of EMIC (in terms of effecting teacher professional growth), and in particular with the success of the course investigated in this study, it is of interest to note that some data suggest that the "quality" of the program presenter is fundamental to the success of any professional development program. The EMIC course investigated in this study was "ideal" with respect to the exceptional ability of the tutor who conducted the program. However, it was obvious from the data collected that this is not always the case. In fact some teachers suggested that program presenters could negatively effect even the best designed professional development. One teacher, for instance, cited an example of teachers in one area refusing to participate in EMIC because of the "horrible" tutor who was conducting the course. In assessing whether professional development programs are appropriate vehicles for effecting the professional growth of teachers it is therefore important to consider carefully the role of the program presenter.

The extent to which the findings of this study can inform how professional development programs, more generally, might act as appropriate vehicles for effecting the professional growth of teachers of primary mathematics is discussed next.
10.2 Professional development programs as appropriate vehicles for effecting the professional growth of teachers of primary mathematics—What has been learned

This study sought to determine whether professional development programs can act as appropriate vehicles for effecting the professional growth of teachers of primary mathematics. The findings of the study suggest that they can—in terms of their own goals and purposes, and under certain conditions.

The EMIC course examined in this study provided one means for the effective professional development of its teacher participants. All of the teachers involved in this study reported and demonstrated growth with respect to their mathematics teaching in the ways described in Chapters 6, 7, 8, and 9, and in Section 10.1.

The importance of the tutor's role in the success of professional development programs is highlighted by this study. The EMIC course examined in this study was conducted by a tutor of exceptional ability, and the teachers perceived the tutor as having a strong influence on their professional growth. Therefore the findings of this study relating to the extent to which the EMIC professional development program acted as an appropriate vehicle for effecting the professional growth of teachers of primary mathematics, cannot necessarily be extended to other EMIC programs, conducted by different tutors who did not possess the same level of ability or commitment.

The EMIC program possessed many positive characteristics linked with key findings from the research literature with respect to effective professional development (see Section 3.2.2). It is therefore not possible to extend the findings of this study to programs that do not possess such characteristics—for instance, “one-shot” workshops or programs where there are no opportunities for teachers to experiment in their classrooms with program ideas.

This study has demonstrated the strong link between the content and outcomes of professional development programs (see Section 10.1.3). The outcomes reported and demonstrated by the teachers reflected the content of the EMIC program—in particular, the teachers focused on pedagogical issues to the exclusion of content issues. The extent to which any professional development program can act as an appropriate vehicle for effecting the professional growth of teachers of primary mathematics is dependent on the suitability of its goals and content. The work of Shulman (1986, 1987) and D.M. Clarke (1997), which highlighted the importance of
teachers developing content knowledge in addition to other areas of knowledge (including pedagogical content knowledge, curricular knowledge and pedagogical knowledge), raises the question of whether programs need to address teachers' development in all knowledge areas.

Much has been learned in this study about the effectiveness of the EMIC program, characteristics associated with effective professional development, and the importance of the goals and content of professional development with respect to effecting the professional growth of teachers of primary mathematics.

The findings of this study suggest that, at least under certain conditions, and in terms of their own aims, professional development programs can act as appropriate vehicles for effecting the professional growth of teachers of primary mathematics.
Case study research offers the opportunity to consider possibilities beyond the immediate setting of the case. In this respect, this study proved no exception. A number of themes that emerged from the data provide opportunities to reflect on different areas of teacher professional growth and professional development programs.

This chapter presents the conclusions and recommendations of this study. Conclusions and recommendations related to teacher professional growth and professional development are made. In addition, recommendations related to research in these areas are presented.

11.1 Change and growth—A useful distinction

The focus of this study when it commenced was on teacher change. A review of the research literature related to teacher change was completed, research questions associated with teacher change were framed, and the collection of data related to teachers’ changing practices and beliefs was planned. However, as the study proceeded, it became clear that the use of the term change was insufficiently precise. This was due, in part, to the many interpretations of change that became evident in the literature across the time of this study (see for example Section 2.1.1). It was also due to the refinement of my own ideas with respect to the difference between change and growth, that occurred as a result of completing this research.

The alternative perspectives on teacher change that were introduced in the literature across the time this study was conducted were discussed in Chapter 2. The ideas presented by authors including Fullan and Stiegelbauer (1991), Johnson (1993, 1996a, 1996b), the Teacher Professional Growth Consortium (1994), and D.J. Clarke and Hollingsworth (1994), challenged previous conceptions of teacher change, and gave recognition to the notion that change can take many forms.

During this study, the process of data analysis involved the construction of definitions that specifically distinguished change from growth. Within the context of this study,
teachers who were observed trying something new or different, or who reported a change in practice or ideas, were considered to have changed some aspect of their professional activity. However, it was only when a change was found to be enduring and in line with the ideas presented in the EMIC program, that it was considered to constitute professional growth (see Section 5.3.2). This distinction proved useful in this study for several reasons.

First, the distinction between change and growth enabled different types of professional activity to be identified. It became obvious that all of the teachers in this study “changed” certain aspects of their practice or their ideas. This was evidenced by the various strategies and activities explored by the teachers, and the ideas they reported. Often the teachers explored similar kinds of strategies and activities, in particular those presented in the EMIC professional development program. However, their “growth”, as evidenced by the changes that were found to be enduring, varied considerably. Teacher growth appeared to be highly individualistic, and the distinction between change and growth made in this study has enabled a more precise discussion of individual teacher growth.

The distinction between the terms change and growth was also useful for examining the different processes involved in teacher change and in teacher growth. As evidenced in this study, there are multiple processes by which teachers change their knowledge, beliefs, attitudes and practice. Similarly there are multiple processes associated with teacher growth. The initial distinction between the terms change and growth enabled more precise descriptions of the processes involved in these phenomena—in particular, the subsequent development of the terms “change sequence” and “growth network” for representing change and growth using the Interconnected Model.

Further, the distinction between the terms change and growth was useful for considering the complex roles of, and relationship between, the individual teacher, the professional development program and the school context, with respect to teacher professional growth. This will be highlighted in the discussions presented in the sections below.

In this study, the distinction between the terms change and growth was useful for describing different aspects of teachers’ professional activity. It may also be useful in other contexts. In particular, it may enable teachers and teacher educators to establish a more precise discourse about teacher change and teacher professional growth. It might also prove useful for describing professional activity associated with change and growth in other professions.
11.2 Confirmation of teacher growth as a learning process

This study provides further evidence to confirm several aspects of teacher professional growth discussed in the research literature (see Chapter 2). In particular, this study confirms that teacher growth is a learning process.

For the teachers in this study growth was highly individualistic. No two teachers demonstrated exactly the same professional growth outcomes, or the same growth processes (see Chapter 8). The teachers' responses to the ideas presented in the professional development program were determined by a variety of factors related to their professional needs, interests and career stages. Many other researchers have similarly noted the various contextual and personal influences on teacher growth (see for example Section 2.1.1). In addition, it was obvious from the data in this study that teacher professional growth is a complex and gradual process. The identification of multiple growth processes demonstrated the complexity of teacher growth.

Each of these characteristics of teacher professional growth can be likened to characteristics associated with student learning that have been advocated in recent years. For example, it is generally agreed that student learning is: highly individualistic; determined by a variety of personal needs and interests; and a complex and gradual process. It seems appropriate, therefore, to suggest that attempts to encourage and support teacher growth should be informed by contemporary theories of learning in other contexts (for example, student learning and workplace learning). Many recent approaches to professional development do this through adopting a learning perspective on teacher change (D.J. Clarke & Hollingsworth, 1994). It also seems appropriate that research studies of teacher professional growth, such as this one, might usefully draw on and inform theories of learning in wider contexts.

11.3 Contextual factors affecting teacher growth

The data collected in this study provide evidence that the effect on teacher growth of professional development programs is influenced by contextual factors that encapsulate individual teacher growth. In particular, there was evidence that teachers' school contexts influence their response to professional development ideas. This
section discusses particular aspects of the school environment that influence growth and distinctive features of supportive school environments.

11.3.1 Aspects of influence

The findings of this study suggest that the context in which teachers work can have a substantial impact on their professional growth. In particular, the conditions evident in a school can either support or impede growth. Figure 11.1 displays a structure for considering some of the possible influences that a school context can have on teacher professional growth. This structure suggests that the school context can impinge on teacher growth at every stage of the professional growth process—that is, with respect to a teacher’s: access to professional development; participation in professional development; experimentation with professional development ideas; and application of professional development ideas. These stages typically proceed in the order suggested by the arrows in Figure 11.1. A school context can influence teachers at any stage. Each of these stages is discussed below.

![Diagram](image)

*Figure 11.1. Influences of school context on teacher professional growth.*

Access

Access to opportunities for professional growth, in particular professional development programs, can vary markedly between schools. Teachers can be actively encouraged to consider information on available programs, or overtly denied access to such information. This access directly affects teachers’ consequent involvement or non-involvement in programs.
Without adequate levels of access to information, teachers can have difficulty making informed decisions about their own professional development. A common result is *ad hoc* participation in programs which have little relevance or interest to participants. However, when access to the range of opportunities available is provided and encouraged in a school, teachers can develop and implement personal professional development plans that are purposeful and effective with respect to both their personal professional growth, and the professional activity of the broader school community.

*Participation*

Schools can encourage and support teacher participation in professional development programs or make it very difficult for teachers to participate. Supportive measures can take the form of:

- financial assistance;
- time release from classroom duties to enable participation in professional development programs, and in recognition of the additional responsibilities associated with program participation;
- peer and mentor assistance;
- the provision of opportunities to communicate program information and ideas to other staff;
- professional recognition; and
- personal encouragement.

Schools that actively encourage participation and also provide teachers with the kinds of support listed above, appear to have a strong positive effect on teachers' attitudes towards their involvement in professional development programs, and subsequently to their commitment to program outcomes.

*Experimentation*

For teachers participating in a professional development program, specific content will be more or less personally meaningful depending on the feasibility of its implementation in their work environments. For example, if conditions associated with the school context are likely to impede or constrain a teacher's experimentation with, or application of, new ideas, the teacher might immediately reject them—that is, prior to exploring such ideas. On the other hand, if a teacher anticipates that the ideas presented in a professional development program might be positively accepted in their
school, it is likely to encourage them to engage in experimentation with the program ideas.

Application

Even if teachers achieve significant learning through their participation in a professional development program, they may not be able to apply their new knowledge or beliefs in practice if conditions in the school environment constrain them. Contextual constraints on teachers' application of new ideas in practice can take a variety of forms, for example: educational philosophy and behaviour management policies; funding; resourcing; and characteristics of the physical setting. The effects of these can be both subtle and complex and can severely restrict teachers' efforts to change.

Professional development programs would do well to assist teachers in their critical reflection on the ways in which their work environment constrains or affords their professional growth.

11.3.2 Creating supportive professional environments

Researchers have identified features of school environments supportive of teacher professional growth (see for example Section 2.1.1). The data collected in this study provides further evidence of many of these features. For example, the teachers in this study suggested that features of supportive environments include:

- a sense of collegiality;
- a culture of professional learning; and
- a positive and strong mathematics ethos (see Chapter 8).

While this further endorsement of characteristics of supportive environments is of interest, it also raises some important questions. For example, given that research findings over the last twenty years have provided consistent messages with respect to these kinds of features (see Section 2.1.1), what strategic steps have been taken to ensure that these characteristics are evident in schools? Some schools have begun to develop and implement plans for creating cultures of professional learning. Many of these schools have developed specific strategies to foster such cultures. For example, with respect to teacher professional development, some schools have developed:

- coordinated approaches to teacher involvement in professional development;
- structures for supporting teachers involved in professional development; and
• structures for teachers to communicate and share information and ideas learned.

While it seems that much is known about the kinds of environments that teachers consider supportive of their professional growth, and that many schools are along the way on the journey to "becoming" effective learning communities (Johnson, 1996a), the question of how supportive school environments are actually created, is worthy of investigation.

11.4 The existence of multiple growth networks and the inadequacy of linear models of growth

The use of the Interconnected Model to represent the process of growth for the teachers in this study confirmed the existence of multiple growth networks reported earlier by D.J. Clarke and Peter (1993), the Teacher Professional Growth Consortium (1994), and Peter (1996).

Several different routes to change and growth were evident for all of the teachers in this study (see Chapters 6, 7, and 8). This significant finding gives recognition to the non-linear nature of growth. It also indicates that teacher growth usually comprises a number of growth networks rather than any one particular growth network as suggested by earlier models (for example Guskey's 1986 model). Importantly, the empirical demonstration of multiple growth networks highlights the inadequacy of linear models of teacher growth.

The existence of multiple growth networks also raises several questions associated with teacher professional growth and professional development programs. For example:

• are some growth networks more prominent than others?
• do individual teachers have personal growth networks? and
• should professional development programs encourage all growth networks?

While it was not the intent of this study to answer these questions, it is possible to consider what was found in this study with respect to each one. First, certain growth networks did appear to be more prominent than others in this study (in particular, the growth network associated with teachers "perfecting their new practices" that is displayed in Figure 10.1, p. 310). Second, there were no obvious individual teacher personal growth networks (see for example Chapters 6, 7, and 8). And finally, considering that there was evidence in this study that the growth of all of the teachers
was represented by multiple growth networks, it might be suggested that professional development programs should be designed to encourage these multiple growth networks. While these findings are of interest, further investigation of these questions is needed prior to drawing any conclusions about the nature of the different growth networks and the role of professional development programs in encouraging them.

The use of theoretical models in the design of professional development programs warrants further investigation. It could be that the development of inservice activity is more effective when guided by a model of professional growth of appropriate complexity. For example, every domain and every mediating link within the Interconnected Model carries its own specific messages for the design of effective professional development. The following examples illustrate the kinds of messages that emerge from the model for the design of professional development programs related to mathematics teaching.

To encourage teacher professional growth with respect to skilling teachers in new practices, a professional development program might specifically focus on practicalities, that is, showing teachers “how to”. For example, how to actually run cooperative group tasks in mathematics.

To support teachers in assessing valued outcomes a professional development program might provide opportunities for teachers to determine how to “evaluate” outcomes. For example, if the use of calculators to improve students’ number sense was proposed, a professional development program might inform teachers of specific student learning outcomes to look for.
A professional development program might encourage teachers to value elements of their existing practice differently. For example, a program might emphasise the positive benefits of encouraging student talk about mathematics during lessons. Teachers who may have previously considered student talk to be negative, might reconsider the value of student talk and subsequently their beliefs in this area might change.

While these examples focus on professional development related to the teaching of mathematics, parallels in other teaching contexts and other professions exist. The Interconnected Model might usefully guide the design of effective professional development activities.

### 11.5 Extending the Interconnected Model of Teacher Professional Growth

The use of the Interconnected Model in this study provided the opportunity to develop many insights into teacher growth. For example, contrary to the notion of change proceeding along a predetermined linear path (for example in Guskey’s 1986 model of teacher change), it appears that teacher change often involves multiple and cyclic movements between the analytical domains of the teacher’s world (that is, the External Domain, the Domain of Practice, the Personal Domain and the Domain of Consequence). Figure 11.2 displays an example of a cycle of reflection and enactment that teachers might engage in as they make changes to their practice.

![Diagram](image)

*Figure 11.2.* Sample change process involving a cycle of reflection and enactment between the Domain of Practice and the Personal Domain.
The diagram in Figure 11.2 represents a cycling between the mediating processes of enactment and reflection which link the Domain of Practice and the Personal Domain (represented by arrows 2, 3, 4, 5, 6 and 7), prior to any reflection associated with consequences (represented by arrow 8) and subsequent change in beliefs (represented by arrow 9). It is important to note that, in some cases, teachers may only cycle between some domains and not others. For example, at times, they may not consider outcomes or change their beliefs at all. Specific examples of this kind of movement between the Domain of Practice and the Personal Domain may have been evident for some of the teachers in this study as they attempted to perfect their new practices (see, for example, Section 10.1.3). The capacity of the Interconnected Model to represent these many different forms of change is a distinguishing feature of the model.

The use of the Interconnected Model in this study also provided the opportunity to consider the effectiveness of the model itself. Some of the findings associated with the teachers' growth provoked a reconsideration of different elements of the model, and consequently, in this section, extensions to the Interconnected Model are proposed. In particular, modifications to two of the analytical domains of the model are suggested. It is also proposed that the model explicitly acknowledge the change environment in which individual professional growth is situated.

11.5.1 The Domain of Practice: From classroom experimentation to professional experimentation

The use of the Interconnected Model to represent teacher change and teacher growth in this study led to the anticipation of the application of the model to other professional settings in addition to classrooms. The impetus for this came from the professional experimentation that some teachers engaged in outside of their classrooms. In particular, several teachers demonstrated and reported experimentation in areas such as professional collaboration and collegiality.

The teachers' professional experimentation outside of the classroom led me to reconceptualise the Domain of Practice as encompassing all forms of professional experimentation rather than just classroom experimentation. This new view of the Domain of Practice is displayed in Figure 11.3.
Domain of Practice

Professional Experimentation

Figure 11.3. Revised version of the Domain of Practice.

This extended view of the Domain of Practice is potentially useful not only for examining teacher growth, but also growth in other professions. For example, this broader conception of professional experimentation can include other professional development foci such as: organisational strategies, administrative skills and approaches to collegial collaboration.

11.5.2 The Personal Domain: The inclusion of attitudes

It is significant that most of the teachers involved in this study reported changed attitudes towards teaching mathematics. In particular, they reported increased enthusiasm for, and satisfaction with, their mathematics teaching. When considering how to represent these changed attitudes using the Interconnected Model, it became apparent that while attitudes seemed to be most obviously associated with change in the Personal Domain, they were not adequately represented by the existing descriptor for that domain which was “Teacher Knowledge and Beliefs”. The comments made by the teachers in this study with respect to changes in attitudes were quite distinct from either changes in knowledge or beliefs. I have therefore proposed the inclusion of attitudes as a distinct and important component of the Personal Domain. This proposed change to the Personal Domain is displayed in Figure 11.4.
Practical implications of this change include the need for professional development programs to explicitly recognise, encourage, and support the development of constructive teacher attitudes.

11.5.3 The Change Environment: The setting for individual professional growth

The discussion in Section 11.3 highlighted the important effect of school context on teacher professional growth. When using the Interconnected Model in this study, it became apparent that the model gave insufficient recognition to the context encompassing professional growth. It is my contention that explicit recognition needs to be given to the fact that any processes of professional growth represented in the model occur within the constraints and affordances of the enveloping change environment. Consequently I have proposed the diagrammatic modelling of the enveloping change environment in a revised version of the model. The revised model is presented in the next section.
11.5.4 The revised model

Each of the changes to the Interconnected Model proposed in the previous sections is present in the revised version of the model displayed in Figure 11.5.

![Diagram of the Interconnected Model](image)

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

*Figure 11.5. The Interconnected Model of Professional Growth (D.J. Clarke & Hollingsworth, 1998).*

The version of the Interconnected Model displayed in Figure 11.5 has developed from the findings of this study. It should be noted that all of my proposed changes to the model were discussed with D.J. Clarke, one of the researchers responsible for the earlier Clarke-Peter Model on which the Interconnected Model is based (D.J. Clarke & Peter, 1993). My advocacy of these changes was encouraged by his endorsement of their practical and theoretical value.

The model has been retitled as the Interconnected Model of Professional Growth (rather than teacher professional growth). This title distinguishes the current model from previous versions, reflects the changes made to the model, and anticipates the model's application to other professions.
11.6 Professional development programs effecting teacher growth—Some issues

The findings of this study raise several issues associated with professional development programs effecting teacher growth. In particular, these issues include: the goals and purposes of professional development programs; the resourcing of professional development programs; and the role of professional development programs within comprehensive approaches to teacher professional development.

While the EMIC program appeared successful in achieving its stated aims, it was, to some extent, limited in its content and therefore in its outcomes. The strong pedagogical focus of EMIC was reflected in the growth reported and demonstrated by program participants—in particular, teachers focused on pedagogical issues to the exclusion of content (see Section 10.1.3).

Given that EMIC was a particularly resource-rich professional development enterprise—in terms of financial outlay, involvement of project personnel, commitment of schools, and commitment of teachers—a question that arises is: is it adequate for professional development programs to focus on developing only some areas of teachers’ knowledge and practice? Two factors need to be considered in answering this question. First, in order that professional development program participants develop expertise in areas other than those included in the program (for example, content knowledge in the case of EMIC), they may need to engage in some other professional development program or some other form of professional activity. However, it is questionable whether resources would be available to support such involvement. It can be anticipated, for instance, that additional programs would require large commitments—similar to EMIC—in terms of financial expenditure, project personnel, and teacher time. The government, schools, and teachers may find it very difficult to make such additional extensive commitments. Second, it should be noted that, it was obvious that teachers greatly valued the EMIC program “as it was”. Most teachers suggested that it was the best professional development in which they had been involved. This suggests that there may be a place for programs, like EMIC, that focus on developing only some areas of teachers’ knowledge and practice.

It appears that the planning and implementation of effective teacher professional development is no small challenge. Professional development programs can be incredibly demanding on teachers, schools and systems. It may be that there is no
simple answer to what is “best” with respect to program design. What can be stated, however, is that there is a need to:

- develop clear goals and purposes for professional development programs;
- provide adequate resources to enable the development and implementation of effective programs; and
- view professional development programs as one part of a comprehensive approach to teacher professional development.

11.7 Reflections on the methodology

In reflecting on the methodology, it is possible to identify some limitations of this study. Many of the decisions made with respect to the design of the study, for example, had to reflect the fact that this research was to be conducted part-time by one researcher. The selection of the number of teachers to be involved in the study, and the type, amount, and frequency of data collected were affected by these conditions. For example, it was only possible to examine the professional growth of six professional development program participants due to the time needed to collect data from each one.

A specific limitation of this study relates to the generalisability of the findings to other settings. This study focused on one particular EMIC course. Therefore, the extent to which generalisations to other EMIC courses, and professional development programs, more generally, can be made is limited. Several factors specific to the EMIC course examined in this study would have directly affected the findings—for instance, the influence of the particular EMIC tutor, and the dynamics of the particular group of teachers who participated. Factors such as these should be taken into account when considering the study findings.

While there were some limitations to this study there were also some strengths associated with the study design. Two key elements in the research approach used were the two phase structure of the study and the longitudinal study design.

The decision to conduct this study in two phases, and in particular to focus the first phase on examining the aims and expected outcomes of the professional development program, proved critical to this study of teacher professional growth. The investigation in Phase One of the EMIC Developers’ views of the aims and expected outcomes of the program was of particular interest. This investigation highlighted some differences between the stated aims of the program and the outcomes of the
program anticipated by those responsible for developing it—these differences were taken into account when designing the data collection procedure for the second phase of the study. This finding has implications for other studies of professional development programs. In particular, it is suggested that researchers examine not only the stated aims of programs but also those outcomes expected by key personnel associated with the development and implementation of the program.

The longitudinal design of this study also proved critical to the outcomes of this research. The length of the study was a particular strength given that teacher change and growth take time. In fact, it is possible that little would have been learnt about teacher growth if this study had not extended over an 18 month period. Few studies of this length have been conducted with respect to the professional growth of primary teachers of mathematics. This is understandable given the sustained commitment required to complete longitudinal studies like this one. However, the findings of this study with respect to professional growth being a gradual and complex process have implications for future research in this area—in particular, it is suggested that other longitudinal studies be conducted in order to further develop understandings of teacher professional growth.

11.8 Research and professional growth—A personal perspective

Throughout this chapter, and in Chapter 10, I have made recommendations with respect to teacher professional growth and professional development programs, and identified areas for further research. In this final section, I would like to reflect on the extent to which my own personal perspective on this study—which was outlined in Chapter 1—has developed through completing this research. That is, how this research has effected my own professional growth.

My initial interest in teacher change has continued to develop in my roles as researcher, mathematics educator, and education consultant. On many occasions I have been able to make use of my new knowledge with respect to the processes involved in teacher professional growth, and with respect to the design and implementation of effective professional development.

Working on this research part-time over an extended period provided the opportunity to draw on the extensive literature that emerged across the time of the study. This
proved particularly positive as I was able to reflect on, make use of, and, in some cases, build on the findings of other recent research.

Just as the process of reflection appeared crucial to the professional growth of the teachers in this study, it was also crucial in the process of completing this study. In particular, the many opportunities to engage in professional discussions with my research supervisors and colleagues provided the stimulus for the refinement of my ideas.

Finally, through doing this research I have confirmed my view of professional growth as a process of ongoing learning—in particular, I consider the completion of this study has marked one significant place along the way in my professional journey.
REFERENCES


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PHYSICAL SETTING

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ASSESSMENT

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NOTES

- GE said planned to use fraction cards
  also got valve to isolate
  - said "they did some great things yesterday"
  - they're really looking at the sizes
    and comparing them.
- GE noted observations of 2 students
  to me:
  1. Be good making a table "at home" -
     suggested all her work reflects
     home experiences.
  2. We boy enjoying exploration -
     noted interesting that he usually has
     difficulty staying on task when
     guidelines set, but "could work
     on the activity till late"
Teacher Interview Schedules: Interviews 1, 2 and 3 (reformatted)

Interview 1

Section 1—Background:

How long have you been teaching at x primary school?
What grade level are you currently teaching?
What other grade levels have you taught in the past?
How many years have you been teaching altogether?
What were your reasons for applying to do EMIC?
How did you become interested in EMIC?
What impressions do you have of the program?
What professional development programs have you found useful in the past?
Have you previously been involved in any mathematics professional development?
Are you currently involved in your school’s mathematics curriculum committee?
Are you involved in any other curriculum committees?

Section 2—Overview of mathematics teaching:

How do you organise the mathematics program in your class?
How effective do you consider your current program is?
What are some of the features of your mathematics program?
Are there any aspects of your mathematics program that you feel concerned or anxious about?
Where do you currently get help with any aspects of your mathematics program?
Have you ever used anyone outside of your school setting for assistance?
Are you aware of any innovative techniques trialed or implemented with respect to mathematics education?

Section 3—Key areas of Classroom Practice:

General teaching approach

How do you decide on the learning experiences to be included in your mathematics lessons?
How do you ensure that the content is relevant?
How do you attempt to challenge all students?
How would you describe the student’s role in your mathematics lessons?
In general, would you describe the type of activities you do in mathematics lessons as open-ended? How do you interpret the term open-ended?

Teaching Strategies

What kinds of teaching strategies do you use in mathematics lessons?
How have you become aware of those strategies? developed over time? pd? other teachers?
Have you read about any strategies anywhere?
Are there any strategies that you have heard about that you would like more information about?

Resource Use

What resources do you use to teach mathematics?
Are there any school produced materials at x primary school?
What kinds of resources are available for students to use in mathematics lessons?
How are the resources accessed by students? stored in the classroom?

Assessment Strategies

How do you currently assess students in mathematics lessons?
Do you keep written records of any kind? What do they look like?
What do you consider to be the purpose of assessment?
What is the role of the students in the assessment process?

Section 4—Mathematics in the school:

How effective do you consider the school mathematics program and policy are at x primary school?
Do you think the policy reflects the school community’s attitude towards mathematics?
Does it reflect your attitude?
What modifications, if any, do you think would be needed to make the policy even more effective?

Interview 2

Section 1—Background:

How effective do you think the EMIC program was in meeting your expectations/needs?
Have you been involved in any other professional development since starting EMIC?

Section 2—Overview of mathematics teaching:

What would you say has been the main effect of EMIC on your teaching? Have there been any other effects? What do you do differently now from before you started the program? Why have you changed these things?
What innovative techniques for mathematics teaching have you become aware of through participating in EMIC? What are some of the things you tried?
Section 3—Key areas of Classroom Practice:

General teaching approach

Has your overall approach to mathematics teaching altered at all due to your involvement in EMIC?
Have you changed any specific views/approaches you take to any particular areas of your mathematics teaching?
What teaching approaches discussed in EMIC would you like to try further?
Are you satisfied with/do you feel positive about the teaching approach you use in your maths program?

Teaching Strategies

Have you tried any “new” teaching strategies in mathematics lessons as a result of your participation in EMIC?
Are there any strategies that you heard about in EMIC that you would like more information about or would like to try?

Resource Use

Have you become aware of any “new” resources related to mathematics teaching and learning as a result of participating in EMIC?
Have you used any “new” resources since starting EMIC?
Have you changed the way you use resources in your mathematics program? Planning resources? Student resources?
Have you purchased any resources as a result of your participation in EMIC?

Assessment Strategies

Has your involvement in EMIC altered your attitude towards the assessment of student’s mathematics?
Have you tried any “new” assessment strategies as a result of participating in EMIC?
Are there any assessment strategies that you heard about in EMIC that you would like more information about or like to try?

Section 4—Maths in the school:

How closely do you consider the mathematics teaching at your school resembles the type of teaching the EMIC program advocates as effective?
Taking into consideration the ideas/issues contained and discussed in EMIC, what changes, if any, would you like to see happen to the teaching of mathematics at your school?

Section 5—The EMIC program:

In your view, what would be the main way the EMIC program could be improved?
What could you have done to get more out of the EMIC program?
What could your tutor have done to improve the program for you?
What issues/areas discussed in EMIC would you like more information about?
Interview 3

Section 1—Background:

How often do you refer to the ideas and/or materials that were contained in the EMIC program? In what way do you use them?
Could you use the ideas discussed and demonstrated in the EMIC program more effectively?
Have you been involved in any other professional development since completing EMIC? How has this professional development affected your teaching? Your view of the ideas discussed in EMIC?

Section 2—Overview of mathematics teaching:

What would you say have been the main effects of EMIC on your teaching over the last twelve months?
What do you do differently now from before you started the program? Why have you changed these things?
Are these things a regular part of your mathematics program or something special or different that you do now and again?
What different or innovative techniques for mathematics teaching have you trialed since participating in EMIC?

Section 3—Key areas of Classroom Practice:

General teaching approach

Have you explored any teaching approaches discussed in EMIC further since participating in the program?
Has your overall approach to mathematics teaching altered at all due to your involvement in EMIC?
How do you feel about the teaching approach you use in your mathematics program currently?
What could you do to improve your teaching approach?

Teaching Strategies

Have you tried any further “new” teaching strategies in mathematics lessons since completing EMIC?
Are there any strategies that you heard about in EMIC that you would like further information about or would like to try?

Resource Use

Have you used any “new” resources since completing EMIC?
Have you changed the way you use resources in your mathematics program?
Have you purchased any resources since you completed EMIC? How do you plan to use them?

Assessment Strategies

Do you consider that your involvement in EMIC had any affect on your attitude towards the assessment of students’ mathematics?
Have you tried any “new” assessment strategies since completing EMIC?
Are there any assessment strategies that you heard about in EMIC that you would like further information about or like to try?
Section 4—Maths in the school:

Has the involvement that you (and other teachers in your school) have had in the EMIC program had any impact on mathematics teaching at your school? Would you say the approach taken throughout the school is fairly consistent with EMIC ideas?

What changes, if any, would you like to see happen to the teaching of mathematics at your school? How do you think these changes could realistically be achieved?

Section 5—The EMIC program:

In your opinion, of what value was the EMIC program to you? Has it affected your teaching of mathematics? Is there anything more you feel the EMIC program “should have done for you”?

What is the next step for teachers beyond EMIC? What do you feel teachers who have completed EMIC could do to improve their mathematics teaching further?

Do you think that you need to continue to improve your own mathematics teaching?

Have you maintained any contact with your EMIC tutor? For what purpose have you kept contact?

What issues/areas discussed in EMIC would you like further information about? How might you find out more about these issues/areas?

Could you sum up your view of the EMIC program?
Pre-EMIC INTERVIEW - TRANSCRIPT

Participant: 2

Date: 16-5-91

SECTION 1: Background
[Focus: Teaching Experience]

- How long teaching at ... Primary School?
  R: Just this year.

- What year level?
  R: 4/5

- Other levels in the past?
  R: (specialist... all levels...)

- Years teaching altogether?
  R: 13

[Focus: Professional Development]

- Reasons for applying to do EMIC?
  R:

- How did you become Interested?
  R:

- What impressions do you have of the program?
  R:

- Useful past PD? Any in mathematics?
  R: The only things I've had to do with maths has been curriculum days within schools. I think there have only been two that I've been involved with there. And a few years ago now I went to a few days at Monash University to a maths thing there.

Q: Was that an MAV conference?
R: Yes.

Q: When were the curriculum days?
R: One was at Albert Park about 4 or 5 years ago, and the other was a while before that.

Q: Can you remember anything about them?
R: It was an In-house day at Albert Park and everyone had to bring some activities along and present them to the rest of the group and it was just a way of getting away from the ordinary approach of doing sums and looking at some interesting activities that maybe people didn't know about, and could possibly use in their classroom.

- Any other areas?
  R: In terms of maths?
  I: any area...

R: Well I did a lot of professional development when I first started PhS ed and that was good; but that was in the olden days where they had every first year PhS ed teacher did a great deal of inservice every second Monday, then ten days at Somers camp and a week of swimming and 3 or 4 days of athletics. It was really thorough so that we just went back... it was so thorough that you knew what to do every week.

Q: Was that like the first year librarians course?
R: No, nothing like it at all. I only did the 4 day inservice when I was first year librarian and... I only did it because no one else in the school would take it on.

Q: What was better about the PhS ed course rather than the librarian one?

R: I had a really, really good advisor who used to come out to see me probably once a month, (laughing) and I used to get him not to take all my lessons for me, but I would get him to take one or two of the lessons so that I could watch him and get ideas and it was great, it was good to see the different teaching experiences that go on in each lesson and... it wasn't tabloid really but yeah it just gave lots of ideas. But I mean over time the number of people able to be in those positions has just dwindled because the finance hasn't been there and that's really sad.

- Currently involved on the maths curriculum committees?
R: No.

- Any other curriculum committees?
R: No. I'm doing, or the other grade 3 teacher and myself are doing the science thing for education week which involves integrating the whole school... but not formally on any committee, no.

SECTION 2: Overview of Maths Teaching
[Focus: Perceptions of Current Practice]

- How do you organise the maths program in your class?
R: I don't use any one particular approach. I try to use a variety and I've always found it necessary to concentrate on one topic at a time rather
than shop and change. Some teachers prefer to do... I like to concentrate on one thing on Monday and have it flowing through that way, and do something totally different on Tuesday. I like to take a topic and take it through, in a particular form, right through in one hit. And then I can find out at what stage - I like to test diagnostically that way too - then I can find out where I've lost them on the way and go back and reteach them. I like to have a wealth of different kinds of courses as a back up that I can take ideas from so I'm not just doing one thing like say Algebra and taking a part of it and doing it from start to finish. I like to try and get as many ideas as I can find.

- How effective do you consider your current program is?
  R: I try to use a lot of ideas because I've found that that's worked better for me.

- What are some features of your program?
  R: The idea of getting the children involved in it. I've just found that... I mean not every child in my class has always learnt everything that I've taught them, but, I think basically at the end of the year I've been pleased with the standards that the kids have attained, and that's what really counts. So, I mean... it's difficult. I mean you're asking me virtually to pick a topic and... I mean your approach has to change. It's not the same all the time. I think that's very important.

- Difficulties in your teaching approach?
  R: No. I'm more conscious of the fact that I haven't been in a classroom for 3 years and I found it a bit difficult to start off with getting back into the normal routine but it's not maths it's...?

- Where do you presently get help with any aspects of your maths program?
  R: There's a maths room where I can go to get things. I raised it earlier this week actually. And there's people. I've got a... across the road who's got a grade 4, there's a downstairs who's got a 5. My grade by the way even though it's a complete, there are 20 4's and only 5 grade 5's. So I tend to work more with... than... But I've also got the 2 grade 6 teachers and I speak to them about things as well so there are 5 people that I work fairly closely with.

- Have you ever used anyone outside of your school setting?
  R: With Jo you don't really need anyone.

- Aware of any innovative techniques trailed or implemented in maths education?
  R: Not really no, because I've been out of the classroom. And that's one of the reasons for me going to EMIC - to find out some of the things that are happening.

SECTION 2: Focus Teaching Approach

- How do you decide on the learning experiences to be included in maths sessions?
  R: It changes all the time, I mean when I choose a topic I've got to think about the type of thing I want to do within that topic and then its just like brainstorming to come up with things to do.

- How do you ensure the content is relevant?
  R: That comes from past experience, from looking through the information that's available to me, that's basically it... but also from sharing ideas with other people - as I said Marla and I work fairly closely.

- How do you attempt to challenge all students?
  R: Well I believe that they should have experience success for a start. So I always try to start things at a fairly simplified level. It's up to me to realise or to know who's finding things easy or who's experiencing difficulties and then modify what I'm doing in order to make things challenging for the people who need to be challenged.

- How would you describe the child's role in your maths sessions?
  R: Probably not enough child based learning... I would first of all go over what we're doing, if it's anything from the board I might show them... if it's a practical activity I have to make sure that that's graded too, because I don't want to mention kids names, but there are some children that need a more difficult challenge so that if we are say doing measurement and I want them to find the perimeter of something, I might make it really easy for the children who have difficulties, but for the children who don't I'd make them do something that... maybe work with larger numbers and stuff like that.

- In general would you describe the type of activities you do as open-ended? closed?
  R: They are probably more closed.
SECTION 4: Focus: Teaching Strategies

Do you use cooperative group work? a problem solving approach? calculators and computers?...
R: Yeh, I use computers and calculators too, but I share mine with Marcia... They might play games... Problem solving... we've done some really good problem solving activities this year with the children like giving them the letters of the alphabet a numerical value and we've done street names and months of the year and all different things like that. I actually like to occasionally give the children a mathematical problem to take home as homework that they can solve with their parents. I try to do that as much as I can to allow the parents to become involved and do something with their children.
Q: What about using computers in maths?
R: Just Logo, but not this year. I'd like to but, I haven't got around to it.
Q: So you've used it in the past? What did you think of it?
R: I really loved it... I mean I would just say to them draw a hexagon and give them no directions and they would just make one. I felt that was great.
Q: And what about using calculators?
R: Yes. We do calculator activities...

- How have you become aware of these strategies? developed over time? PD? other teachers?
R: Some from an Inservice, but mostly just by trying them.

- Have you read about any strategies anywhere?
R: No.

- Are there any strategies that you've heard about that you would like more information about?
R: No.

SECTION 5: Focus: Resources

- What resources do you use?
R: I've got Rigby and a couple of others over there, I've got Guidelines In Number, Victorian Primary Maths and about 3 or 4 others. I've got... and I used that a few years ago. I really liked it because it had everything we were doing in the school at that time, in the curriculum, plus more and it was all introduced from a problem solving point of view which I really liked - that was interesting.

- Are there any school produced materials at...PS?
R: Well we have a policy. Everyone at the school has been EM/Ced except for [name] and myself and so they're all sort of using it.

- What kind of resources are available for students to use in sessions?
R: I have some things available like unifix - mainly unifix and MAB, and if we're doing practical stuff then whatever we need for that particular lesson.

- How are the resources accessed by students / stored in the classroom?
R: We get them from the maths room, they're not really stored in the room because the idea is that you borrow them from there and then return it...

SECTION 6: Focus: Assessment & Reporting

- How do you currently assess students in maths sessions?
R: Well I test whatever I've done. I'm not testing just to get a mark, but as a measure of what the children know and what I need to repeat.

- Do you keep written records of any kind? What do they look like?
R: Well, if I'm going to do something where I give them a score out of ten then I record that on a list.
Q: Are there any other sorts of records?
R: Only odds and ends like tables - I still think they're important - I do tests on those to see which ones they know...

- What do you consider the purpose of assessment?
R: The purpose of any testing is to find out what the children know and it also helps you evaluate what they know and what they don't know so that you can do something about what they don't know. And also it helps you with teaching. I mean if you teach something and find out that the children haven't grasped the concept that you were trying to teach obviously you need to do something about it.
SECTION 7: Focus: Maths in the school

- How effective do you consider the school maths policy and program?
  R: That's hard for me to answer really because I'm new to the school.

- Do you think the policy reflects the school community's attitude towards maths?
  R: That's also too hard.

- Does it reflect your attitude?
  R: Yes... I think I've got updating to do, and that's why I'm doing EMC.

Because things have definitely changed and it's happened fairly quickly and I haven't been teaching in a classroom in that time.

- What modifications, if any, do you think would be needed to make the policy even more effective?
  R: No.

Ending the Interview...

- Is there anything else related to your maths teaching that you want to tell me about?
  R: Only that I really enjoy teaching. I love it.

Q: Do you think that attitude has any effect on your students?
  R: Yes, I think it does. I've always enjoyed it and I'm really positive about it.

Q: Anything else you would like to add?
  R: I'm looking forward to EMC, because I haven't done anything like this for a long time. I feel like I'm a bit outdated.
Post-EMIC INTERVIEW

(30-8-91)

Introduction
- Welcome
- Comfort
- Outline procedure - question/answer format in sections

Section 1: Background
[Focus: The EMIC program]
- How effective do you consider the EMIC program was in meeting your expectations?
  - Was the program similar to what you expected?
  - To what extent did it meet your needs?
  - What issues were not covered that you expected to be covered?

R: (it really opened my eyes, I thought it was great, I really did. I didn't really have huge expectations. I mean I just went in there with an open mind. It just happened that way. It wasn't as very different to what I thought it was, so it just didn't really make it.)

[Focus: Professional Development]
- Have you been involved in any other professional development since starting EMIC?

R: No.

Section 2: Overview of Maths Teaching
[Focus: Perceptions of Current Practice]
- What would you say has been the main effect of EMIC on your teaching?
  - My teaching methods have changed in regards to teaching pupils and teaching to everyone bringing in their own work and stuff like that and they can. I mean, I did nearly all of these activities in groups and there were very few girls, I didn't use it. I feel that it was more for the ability and well then I would modify them for my kids. Yes, yes.

F: While you're teaching teaching methods.

R: What have been the other effects?
  - What do you do differently now from before you started the program?
  - Why have you changed these things?

[Focus: Perceptions of Innovation]

Section 3: Focus Teaching Approach
[Focus on approach...constant/challenge/activity type...]
- Has your (general) approach to mathematics teaching altered at all due to your involvement in EMIC?

R: Covered.

- How have you changed any specific views/approaches you take to any particular areas of your maths teaching?

R: Covered.

- Have the children improved and learning through their doing? Not me telling them that this is what they're supposed to be doing. Instead, I give them the opportunity to explore this. And there is a lot more where they're easier and for individuals where it's harder, they have more chances to do things that are new or they try and find their way around.

Although I've always felt that kids probably learn better from other children than they ever do from listening to a teacher. And so, they're more interested in participating in the activities as well. At a time change in life, I found that through adopting an EMIC approach to teaching the EMIC program I've done a fraction with using an EMIC approach, I mean it's a unit that I've designed. But I followed that and it's being successful, the kids are really picking it up... They understand what they're doing and they've enjoyed it. And I've liked watching that. I've enjoyed it too.

- What teaching approaches discussed in EMIC would you like to do further?

R: Well I feel like I've tried everything that I've been presented with. So, that's difficult to say. I don't feel like I've tried everything that was suggested. I don't feel like I've held back and not had a go. So... and I'm not really creative, so no.

- Are you satisfied with... do you feel positive about the approach you use in your maths program?

R: Yes, much happier, much happier.

Section 4: Focus Teaching strategies
Section 5: Focus on Resources

Have you become aware of any new resources related to maths teaching and learning as a result of participating in EMIC?

R: The kids are using more computer programs in maths now as a result of using ImagiMaths. This has been very beneficial for them, as they are able to see the concepts in a different way. We have also purchased some new maths books and tools which have been very helpful. We are also using more software programs such as Mathletics, which has been a great aid in helping the students understand mathematical concepts.

Have you used any new resources since starting EMIC?

R: Yes, we have used Mathletics, which has been a great help. We have also purchased some new maths books and tools which have been very helpful. We are also using more software programs such as Mathletics, which has been a great aid in helping the students understand mathematical concepts.

Have you changed the way you use resources in your program?

R: Yes, we have changed the way we use resources in our program. We are now using more computer programs and software tools to help the students understand mathematical concepts.

Section 6: Focus: Assessment & Reporting

Have your observations in EMIC added to your assessment of children's mathematical skills?

R: Yes, we have observed the children's progress in EMIC and have noted that their understanding of mathematical concepts has improved. We have also noticed that they are more engaged in the learning process and are more willing to participate in the activities.

Section 7: Maths In The School

How do you assess the impact of EMIC on the students' learning?

R: We assess the impact of EMIC on the students' learning by observing their progress and noting any changes in their understanding of mathematical concepts. We also conduct regular assessments to evaluate their progress.

T: I'd like to try some, but they're just a matter of getting back into the EMIC folder. It's still fairly fresh.

T: That's a great system, isn't it? Everything is well organized and easy to access.

R: Yes, it's a great system. Everything is well organized and easy to access. We are also using more software programs such as Mathletics, which has been a great aid in helping the students understand mathematical concepts.

T: I think it's a great system. Everything is well organized and easy to access. We are also using more software programs such as Mathletics, which has been a great aid in helping the students understand mathematical concepts.

T: I think the system is great. Everything is well organized and easy to access. We are also using more software programs such as Mathletics, which has been a great aid in helping the students understand mathematical concepts.

R: Very much so, because...
changes. If any, would you like to see happen to the teaching of mathematics at your school?

Curriculum/Organisation:
R: No I think our school is up to date. I mean X took charge. This is my first year here, but it's because the kids take charge and people get more involved. I think that's one of the changes that people are happy with following the EMIC approach. I think it is.

Teaching Approach:
R: I think we could do some more coordination in organizing and planning programmes. Obviously there's policy within the school, but that could be extended. I think teachers should be involved in it. One day I was training with the teacher over the pupil, and we discuss, like the term we did a unit that went for the term, and we're doing one this term as well. And our maths has basically these bases and bases of problems solving, we've just done the last two. It's and much more as of different things. So we plan together.

Teaching Approaches:
R: I think we could do.

Section 2: The EMIC program

In your view, what would be the main way the EMIC program could be improved?
R: I don't really think that there was that much wrong with it to be perfectly honest. Everyone was more or less comfortable. No one in that group really asked and didn't accept anything at any stage and I think that's important. I mean obviously some took more than others, but I think we should encourage everyone to participate. The only thing that I would like included in it is a bit more of an introduction. I suppose it comes back to what you were saying about a group of questions at the beginning of the year, so let's develop a course and a whole course using the EMIC approach, maybe that's just not a problem to stages when I was running away and doing all these fantastic activities, but they weren't really involved. I suppose I was doing them because I wanted to have an in there because they were doing so; great. And I think let's open about things together everyone talking into the program not necessarily but you're already got, but you can do it later on to usually change it. There are still skills that children have to apply and that still needs to be put down, but let's use the EMIC approach to teach them. And we don't know. I think there's less teaching there are these fantastic activities and I really think there is a lot of teaching. So I don't necessarily want to do it away everything I did in the past because I don't think that's a good idea. Just planning, course, planning I suppose.

What could you have done to get more out of the EMIC program?
R: No because I didn't do what I was asked to do.

What could you tutor? Have done to improve the program for you?
R: No, she was great. She really was great.

What lessons/lessons discussed in EMIC would you like more information about?
R: No, that's all, the planning. I've thought about it several times. No.

The EMIC program has a great deal of information - before we conclude, is there anything else related to your maths teaching that you want to tell me about?
R: No, only that I'm enjoying more and more and the kids. And I'm really glad that I've done it. So start off with the children as taking it and not with horror because I think
Final EMIC Interview

(25-8-93)

Introduction

- Welcome
- Comfort
- Outline procedure - question/answer format in sections

Section 1: Background

(Focus: The EMIC program)
- How often do you refer to the ideas and/o materials that were contained in the EMIC program?

R: All the time.

In what way do you use them?

R: Well, at first I was working on the whole program and then we moved on to the local materials. We go through the materials in the program and then we select the materials that are relevant to that week. Then by discussing it and using it as well, then we come up with new ideas that we can use, so that what's not done having everything formal like it used to be.

Do you use EMIC ideas/approaches/materials/resources often, sometimes or rarely? COVERED

- Could you use the ideas discussed and demonstrated in the EMIC program more effectively? COVERED
- Could you describe how you would do this?

R: I think it probably would be really good to have a follow up. You know how we do the six weeks, I think everybody involved in the program will need every idea that's been discussed. But if it was probably be really good or worthwhile if say the next year you had a course of follow up sessions to see how everyone's going with the various ideas that have been discussed so that they can share. I don't think there's enough of that kind of thing, just sharing ideas and stuff, and because I think people always benefit when you see other people. I'm still different what you've got a whole program to do it so it's specific to one particular subject, I think the more that you can share and more ideas that you can be presented with the easier it is.

(Focus: Professional Development)
- Have you been involved in any other professional development since completing EMIC? (Yes)

R: How has this PGI affected your teaching?

Your view of the ideas discussed in EMIC?

Section 2: Overview of Maths Teaching

(Focus: Perceptions of Current Practice)
- What would you say have been the main effects of EMIC on your teaching over the last twelve months?

R: Well what I always say to you about the EMIC program was always extremely formal. Any maths teaching was always formal. Obviously the whole idea is to have a lot of time and quite a lot of time spent on the various ideas and doing it. And I've been very aware of that. And now it's been a lot less formal. It's not that we've always been doing the activities, it's more that we're able to do the activities and get interested in the things that the children enjoy and benefit from. So it's not as matter of fact. There's more and discovery type thinking.

- Have there been any other effects?

R: No, not really.

- What do you do differently now from before you started the program?

R: Why have you changed those things? COVERED

- Are these things a regular part of your mathematics program, or something special?

Yes, different that you do now and again? COVERED

(Focus: Perceptions of Innovation)
- What different or innovative techniques for maths teaching have you tried since participating in EMIC? Could you describe your experiences / give examples?

R: A lot of it was new to me. Just from what I was reading in the latest research. I had an idea that I had been using and doing during the time, and obviously the Frameworks have changed that. And I mean that's probably the biggest difference. I'm not sure if I used the Frameworks in a different way, but I think the Frameworks have made me aware of the Frameworks and things like that. It's not that it's better to do the things, but it is a lot different. I mean that's probably one of the biggest differences. So far, it's a lot of different things, I mean that. Obviously I have lots of things that they need to be doing, it is that...
Section 6: Focus: Teaching strategies

(Focus on strategies eg. grouping, physics, maths/video/calculators...)

- Have you tried any further 'new' teaching strategies in maths sessions since completing EMIC?
  Could you give some examples of how you have used these strategies...

R: No. I've got a resource person here that I can go to anytime I need to. I mean I could go and ask any questions and they'd get me a unit... and she'd do it. It's great, we've actually done it. There's a lot of sharing here, it happens all the time.

- Are there any strategies that you heard about in EMIC that you would like further information about or would like to try? COVERED

Section 5: Focus: Resources

- Have you used any 'new' resources since completing EMIC?
  What are they?
  Could you describe how you use them or give examples...

R: Well, we use more resources than I used before. I'm in the maths room quite frequently. There are different ways to do it. I use key stage resources that are given to me, whatever I'm doing at the time. The children use them as well. I've got stock of these, and it's the example we've used for this year. We've got a few more resources that we've used in the last year. We're lucky again with it because we've got so much to draw from. And we just chose activities that were suitable for our children, our level.

- Have you changed the way you use resources in your program? How? Can you give examples...
  Planning resources...
  Student resources... COVERED

- Have you purchased any resources since you completed EMIC?
  What kind?
  How do you plan to use them?

R: No, we haven't done that. But we've got, we've got one that because she's bought these packs of maths (Maximillian), and we've got these cards where these cards are fantastic, but they're not suitable for this form. But because there's a lot of equipment that needs to be used with them. So I think it's the only way we could use them well is if we could get together as a staff and get around the school and find all the equipment that you need, like make a list. So we've got these particular cards on maths and we've got to make a list of all the equipment that is needed for the children to be able to work from these cards. Then we've got a great big box full of all this equipment for these cards, and then I'll be able to give each child a card and they can get to the card and get the equipment they need, and the cards will be in the box (distribution).
Section 2: The impact of EMIC & future directions

- In your opinion, what value was the EMIC program to you? Has it affected your teaching of mathematics?

  R: It was great value to me. How do you want me to answer it? It has obviously affected my teaching of math.

  C: Is there anything more you feel the EMIC program should have done for you?

  R: No, because I mean the minute that you do something that makes you sit up and take notice it makes as big impact. EMIC if it can make you change your practices which it did have. I don't believe in it ever to be improved.

  C: What is the next step for teachers beyond EMIC?

  R: What do you feel teachers who have completed EMIC could do to improve their math teaching further?

  R: Well I think that if there was a second part to the program. For example if there's a protocol the behaviour program, but then there's a second stage to it which follows on. I can't see why there couldn't be a second stage to EMIC.

  C: What do you envisage that would look like?

  R: It would be like doing a refresher course. For example with AUSTSWIM every couple of years you go and do a refresher course. I don't see why you can't do that with math or language or whatever. So I mean if it is possible I think it would be of benefit. You don't necessarily have to make a big because obviously the program is run out of school anyway. So I don't see why we couldn't have a couple of times. I don't think it needs to be big.

  C: Do you think it is necessary or would be beneficial to have those sessions run by a mentor?

  R: Well it would be fantastic if you could have the same person again. If it was all possible it would be fantastic, because then you don't have to worry about being studied. That's what the audio told sorry, but you don't have to worry about being studied. But being the same school and all. That would be the way out to try and apply it. If I was doing this, I would try and get the same group back, if people are still in the same area. I might be hard doing that, but I suggested that it be within twelve months, so most people would be in the same place.

  C: Do you think you need to continue to improve your own maths teaching? Omitted (Yes)

  R: What do you think you will do next to continue to improve your maths teaching? Do you have any plans?

  R: Not really. No, I wouldn't. I'd be more interested to do something in another subject area for example music, music that will take a focus of one subject area.

  C: Have you maintained any contact with your EMIC mentor? Covered (Yes) For what purpose have you kept contact? Covered

Section 3: Maths in the School

- Has the involvement that you (and other teachers in your school) have had in the EMIC program had any impact on maths teaching at your school? In what way? Can you give examples?

  R: Well every single staff member at this school had done the EMIC program, even the specialists have done it and therefore obviously has to have a beneficial effect on the students.

  C: Would you say that the approach taken throughout the school is fairly consistent with EMIC ideas?

  R: Yes. From what I can see everyone is doing real and maths and using the EMIC approach as much as possible. We all get together every now and then and we know what we do in those situations, but apart from that...

  C: What changes, if any, would you like to see happen to the teaching of mathematics at your school?

  R: I think the teaching of maths at this school is pretty good. I think we're lucky, we've got a great principal, we've got a fantastic mood. What's always things that we can use.

  C: Have you any question that you can ask questions on? Any changes necessary? I don't think so...

  R: How do you think these changes could realistically be achieved? Covered... Covered...
• What issues/areas discussed in EMIC would you like further information about? How might you find out more about these issues/areas?

R: No, I feel quite comfortable with it.

• Could you sum up your view of the EMIC program... What impact has it had on your teaching?

R: Well obviously from what I've said to you I think it was great. I mean it was really worthwhile. It did a lot for me, and from other kids that I've spoken to that have scored on the EMIC program, they obviously got a lot out of it as well. So, it would have to be more or being a success.

• I've collected a great deal of information - before we conclude, is there anything else related to your maths teaching or to EMIC that you want to tell me about?

R: It would be nice to think that everybody did it. It really would. It's not, you know, hard-headed people that do a lot of things along the way. It's the other kids that will be more in these subjects. It's something that we'll have to address if I would initiate something like this. But it's not something that we'll leave out. So therefore it would be great if everybody did it. Obviously because you're not doing it in school levels, and people that want to be involved in the program have to be prepared to give up some time out of school hours, that will stop people and there will always be people who don't do it, and I think it's a real shame, because the kids need so much from it, and that's what it's all about. And their parents would really benefit as well. It's no different.

• Thank you for your assistance.
EMIO Participant Questionnaire
- November 1991 -

Name: ____________________________

Write down two important things you have learnt about maths teaching & learning from your participation in EMIO.

It can be the different approaches one can use when teaching maths.

Write down at least one thing about teaching maths which you have continued to find difficult.

At EMIO we did lots of great activities, which I have used in the classroom. However, they were used as isolated activities. I'd like to continue in tying up or adapting an EMIO approach to the local maths programme.

What would you most like more information about/assistance with in regards to teaching maths?

Definitely what I've written about in the above.

How do you feel about your maths teaching at the moment?
(a) interested  (b) relaxed  (c) worried  
(d) successful  (e) confused  (f) happy  
(g) bored  (h) rushed  (i) frustrated  
(j) Write down a word of your own ____________________

What in the biggest worry affecting your work in teaching maths at the moment?

Having everything tied in (as in other subjects).

How could you improve your maths teaching?

By sitting down for an hour or so with a colleague or someone similar, and finding some direction for myself.

Many thanks,

Hillary,

**RECORD OF PROCEDURE**

<table>
<thead>
<tr>
<th>TERM</th>
<th>WEEK ENDING</th>
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**DURING EMIC**

- **Math:**
  - Focus on multiplication
  - Discuss, try problems 10, 15, 20

- **Science (Page 35C)**
  - Discuss, activity of hour
  - Talk about the environment

- **Language:**
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  - Work on vocabulary

- **Art:**
  - Paint, draw, craft

- **Music:**
  - Sing, play instruments

- **Science:**
  - Experiment with magnets

- **Specials:**
  - Physical education

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Categorised data code text file:
CP/ASS - Classroom Practice—Assessment Strategies

ASSSTR: assessment strategy

Interview 1

I'm looking and I watch to see if they understand what they're doing and make an assessment that way... Anecdotal notes; that sort of thing... [D1.6]

Well I don't think that they know that they are being assessed, in fact I'm sure they don't. I'd rather just observe them informally. I'd rather do it that way. Sometimes I like them to take a formal test but mostly I'd rather they just didn't know. [D1.6]

I like to take a topic and take it through, in a particular form, right through in one hit. And then I can find out at what stage - I like to test diagnostically that way too - then I can find out where I've lost them on the way and go back and reteach them. [JMI.3]

Well I test whatever I've done. I'm not testing just to get a mark, but as a measure of what the children know and what I need to repeat. [JMI.6]

Well, if I'm going to do something where I give them a score out of ten then I record that on a list... Only odds and ends like tables - I still think they're important - I do tests on those to see which ones they know... [JMI.6]

... I do keep a little book and just jot down things as I note them. And I used to test them, I used to give them an end of unit test, but I've stopped doing that. Now what I say to them is okay, I'm going to give you four of these problems, and when you've done them, you can go on and read or continue on with some other work, and those problems usually are enough to gauge it. It is still a type of testing, but they don't know it as testing. [KLI.7/L1.8]

And at the moment, my evaluation, when I finish a particular thing I do the normal sort of testing, and I've got their work kept in folders with their bits of paper that they do their working out on and the cards that they work with, and I constantly go around and check what they're doing. [C1.3]

Well, previously I've been assessing them and testing them at the end of a unit, pre-testing them and then testing them at the end of the unit. In fact I'm currently pre-testing at the moment. At the moment I'm into asking them what they know, for example about clocks, or I may specifically ask them to draw the time on a clock and ask them to tell me about that, so the testing may take a variety of forms depending on what we're doing. Like for money and multiplication we had a cake stall and they had to give change and things like that. Some practical things, but not all the time, it's too hard to do that. [C1.7]

Depending on the type of thing and the levels I want them to achieve, I might have say for the multiplication, able to automatically remember tables, so it's like a checklist. [C1.8]

ASSSTR: 1
Well we do have a special file of Rigby things, and it's a bit like what they can do. I suppose it's like a checklist, and we try to keep that up to date. Every child has one of those, so we record what they actually can do... Mainly on assessment, everyday, like I've been writing down this morning little things about children that I know they can do. I am a very observant person, and also with a bit of experience, sometimes when you've got experience, you don't have to write every little thing down, you sort of get to know very well, and I am observant and I feel I do know what the children can do... So I have an ongoing way of assessing, perhaps jotting some things down, and keeping the current file of what they can actually do. [JT1.8]

I don't make assessment marked or anything, although they do like sometimes things to be marked and to see they got it all correct. There's nothing wrong with that I don't think, as long as you don't over-emphasise it. [JT1.6/1.9]

Just observation. I haven't even got checklists set up yet because I'm still getting to know the children and I'm not ready to fill in the Rigby ones yet. At the moment there are sort of no set patterns. Things like that are just beginning to develop and happen and the next step will be to record more about what I'm specifically observing. I have looked at Rigby and I'll probably photocopy that to start. [LL.6]

Interview 2

I find it quite hard to assess them in the EMIC way. I find that difficult. I'm not good enough at that I feel. I'm perhaps not confident enough. I mean I have always jotted a few notes and things down, but not to such a degree like I think is required by the EMIC program. I need more practice in that area. [D2.4]

I'm assessing them in a different way now. Rather than correcting books and seeing if they've got everything correct, or finding out what I thought they didn't know and then trying to help them that way. I can get a better overall view now from watching them, from listening to them, from questioning them about what they're doing. I actually learn more about the children as people from what they're doing and watching them now. And not just from the maths point of view but I get a better overall picture. [JM2.4]

Well obviously in the end you do have to come back to the abstract. I mean problem solving and stuff like that they've actually got to get to the stage where they are doing work in books too, and so I look at their work as well. I don't use columns with what they got out of twenty, I'm more likely to be writing notes about their work, what I observe. That was one of the things that I learnt from EMIC, and I immediately came up and did it, you know got out the grade list and watched them, and just made comments. Not necessarily about every child but I noticed that some things really stood out that needed putting down. [JM2.4]

... most of my previous observations would have been from seeing how they went on their written work because most of our work was recorded. And now
a lot of our work is not formally recorded and so I'm using different criteria to judge them. So I guess a lot of it must be more almost, anecdotal and less right and wrong by what's on the paper... I feel a bit vulnerable here because I've got this suspicion that I'm a bit airy fairy now. It was easier in the past when I was more algorithm-centred for want of a better description, I could say can do long multiplication but struggles with division, okay on decimal fractions and it was really easy to record those things. [K2.5]

Anecdotal yeh, sure. I've been working on that in coming to terms with the literacy profiles and I'm trying the same sort of thing in maths. I had checklists for the way I was teaching, but my teaching is so far away from what it was that my old checklists are not really relevant to what I'm doing. And I haven't got new checklists. I should have but I don't have. I see a big need for them, but it's sort of on the backburner, it should be done. [K2.5]

I've used more of a profile situation. This school actually has one, but it's not used. But I have picked it up and put problem solving on it because it wasn't written on it. And that, and Joan Dalton which I picked up again from EMIC, because I'd looked at it previously and thought about it and you know what you do, and put it back, but that again has some good ideas how to break up problem solving for example and how to break up the areas so that you see that they're covered. And that's forced me, well made me more aware that there are other ways to do it, it's my own checklist, it's a profile with written comments. But every now and again, I've been trying hard to use anecdotal, but that's something I force myself to do maybe because of EMIC. [C2.5]

Well I always did checklists where I wrote the lists across the top, but that was tedious. And then I used Rigby for a while. It's checklists, but you've got to go through wads. Well what they produce for a start. You say well that person understands that. Or really answering questions or cooperatively working in groups, but they're more observation. Diagnostic testing I did anyway, because like I said you need to find out where they are. [C2.5]

... we actually did have a checklist [Rigby]. We had that put into place in every child's file. The idea was that we weren't giving marks and that would indicate to teachers their areas of strength and weaknesses. I think probably one thing that we didn't do much before and I can see now is of really great value is the anecdotal one with the book where you just note things down that you notice the way children are working. Because see when children are working cooperatively in groups you can stand back, whereas when you've got a more teacher oriented approach you're up there and you're doing the lecturing and they're all sitting there and listening, you really don't stand back and watch the way they are working. Whereas in this sort of way you can sort of sit back and watch carefully and you get a very good idea then of little things that crop up. But I do that for other areas as well, not just maths... But I think that it does give you a good time to observe, and I think I'm a bit more aware of that now observing children, you can get more of an idea than if you're out the front. But we did try to get away from our old reports, we have, we've changed our whole report form and we've planned that carefully, and when we
report we report on skills or what they can do in that sort of way. So we have been looking at that, not just giving a mark or an A or anything like that.

... the thing I’ve done is mostly having a sheet of names beside me, and I’ve found that’s really good for quickly checking off what the kids are doing and I’m not worrying about doing it too formally so much now, it’s more having that information for when it comes to write up a report or parent-teacher interviews, that information will be there or I can summarise it before hand. But just keeping a bit of a checklist going would be the main way I... it seems to be the best thing to do with infants.

The checklist type thing seems to have stuck in my mind, as being an observation type thing, while they’re doing things, to take notes and...

**Interview 3**

... it’s obviously much more acceptable now to take anecdotal records of children. It’s not something that is seen as oh, you’re doing that because you can’t be bothered doing a test. It’s much more acceptable, so yes it’s made it more comfortable.

I still do take little tests. I use a combination of those.

I always thought that the way to assess children’s performance in mathematics was to give them a test and whatever they got, like if it was worth 20 and they got 19 they had done really well, and if they got 10 they had done rotten, which is a very old style too. Now I’ve realised that important things are observation, and there are so many more things to evaluation than just a score on a test. So when my kids are working in pairs or groups I spend as much time watching the children, the way they interact with one other and I tend to have a list and make comments about things that they do and stuff just for a personal record. I think that’s as important as anything else that they can do.

I use checklists and anecdotal comments, and observation. I do tests, but there is formal too. Also questioning, and I use observation a lot more than I used to, but then, well, not really more than I use to, it’s different than what it used to be. Rather than just going around and looking in their books, it’s watching them in action with what they’re doing. And also verbally, talking to them.

And also in testing. I can give them a written paper, and I will give them written papers, but they’re more for me to work out where we’re going next rather that to say to parents consistently gets this right or consistently gets that wrong. I don’t know if the parents understand that the attitudes are as important as I think they are but it has certainly affected my assessment. I’ve changed what I’m looking for or the emphasis on what I’m looking for. I use things like this week I gave the kids some text book problems and looked at their written work to see what they remembered. But my key thing is...
observation from the small group. So I'll have observation of not just small groups but also some distance observation. And I think they're the main ones, I don't have other methods that I am using. I hope I do eventually, but I'm not practising any. [K3.5]

Well, I could have the kids assess themselves. I've done some of that earlier on this year and we just spoke this week in our area meeting, we're doing the same next week, because we have to interview parents soon. But they're mainly about attitudes and self-evaluation. I could try but I haven't before, peer evaluation, how you think other members of your group are going. I've never done that, but that's something that I may do. [aware of, not yet practising...]

I regularly test, pre-test ...

... it [EMIC] showed you beyond the checklist variety, you can do informal observational work and you can have them working in small groups, they don't have to work by themselves, you can see what they learn from each other. Yes, some of the anecdotal records I have used, but I still tend to revert to a checklist type system or testing and then getting things back. I'm not sure why, but you tend to revert back to what you know. I find that sometimes how I do my maths and how I assess it is not right because even though I try to make the tests try to cover problem solving and the processes, and give them diagram work or whatever, sometimes I don't feel they reflect what we've done. The children still do alright but they don't necessarily reflect what we've done, but I don't know how you do that. Do you test completely objectively or not?

... more observation time with children... it just gave me more time to stand back and look at them. [J3.5]

... I did some anecdotal records... [J3.6]

Just watching the children work, observing and talking to them more about it. I'm more interested in what they've got to say about things. [L3.3]

We've actually started a little maths process book just recently because I thought they've got a lot to tell me, and I've never listened to what they've got to tell me before. So now I've got a little book going and I'll say go and do something in there to do with maths when they've finished their work, and they've just started doing that. I talk to them about it and they allow me what they can do. They record pictures and symbolic work. Some of them are into sums and large numbers, identifying hundreds, tens and units. [L3.3]

I guess I'm just a little bit more observant trying to tune into what they're doing and why they're doing it. And I want to more often use checklist type evaluation rather than anything formal, I really shy away from that. Sometimes I do some of that, but I think the whole flavour of the EMIC program was that if you observe the children during the year it's good. And I've found that kind of approach really good in language for completing the profiles, so if the mathematics profiles come out, I think the checklists will be a much better way to go than a formal test because you've got a bit more information, and you can keep adding to it. I like that form of assessment better than any really. Sometimes I work with children one to one or withdraw them if I have someone else to give me that time. I don't remember a lot on assessment from EMIC. It would have been nice if we had some more time, perhaps another one or two sessions to really look at that. But I think I remember that the checklist type approach was mentioned and just observing and watching what was happening and listening. So keeping records like that in maths was new. [L3.5]
Categorised data code text file:
CP/ASS/REC - Classroom Practice—Assessment Records

ASSREC: assessment records

Interview 1

Anecdotal notes, that sort of thing…

Well, if I’m going to do something where I give them a score out of ten then I record that on a list. Only odds and ends like tables - I still think they’re important - I do tests on those to see which ones they know...

Depending on the type of thing and the levels I want them to achieve, I might have say for the multiplication, able to automatically remember tables, so it’s like a checklist.

Well we do have a special file of Rigby things, and it’s a bit like what they can do. I suppose it’s like a checklist, and we try to keep that up to date. Every child has one of those, so we record what they actually can do. Naturally we have reporting, we’ve gone with the written reports now, so we try to be specific when we report on them to parents about what they can do. Mainly on assessment, everyday, like I’ve been writing down this morning little things about children that I know they can do… So I have an ongoing way of assessing, perhaps jotting some things down, and keeping the current file of what they can actually do.

I haven’t even got checklists set up yet because I’m still getting to know the children and I’m not ready to fill in the Rigby ones yet… the next step will be to record more about what I’m specifically observing. I have looked at Rigby and I’ll probably photocopy that to start.

Interview 2

… most of my previous observations would have been from seeing how they went on their written work because most of our work was recorded. And now a lot of our work is not formally recorded and so I’m using different criteria to judge them. So I guess a lot of it must be more almost, anecdotal and less right and wrong by what’s on the paper… I feel a bit vulnerable here because I’ve got this suspicion that I’m a bit airy fairy now. It was easier in the past when I was more algorithm-centred for want of a better description, I could say can do long multiplication but struggles with division, okay on decimal fractions and it was really easy to record those things.

… we actually did have a checklist [Rigby]. We had that put into place in every child’s file. The idea was that we weren’t giving marks and that we would indicate to teachers their areas of strength and weaknesses. I think probably one thing that we didn’t do much before and I can see now is of really great value is the anecdotal one with the book where you just note things down that you notice the way children are working. Because see when children are working cooperatively in groups you can stand back, whereas when you’ve got a more teacher oriented approach you’re up there and you’re doing the
lecturing and they're all sitting there and listening, you really don't stand back and watch the way they are working. Whereas in this sort of way you can sort of sit back and watch carefully and you get a very good idea then of little things that crop up. But I do that for other areas as well, not just maths... But I think that it does give you a good time to observe, and I think I'm a bit more aware of that now, observing children, you can get more of an idea than if you're out the front. But we did try to get away from our old reports, we have, we've changed our whole report form and we've planned that carefully, and when we report we report on skills or what they can do in that sort of way. So we have been looking at that, not just giving a mark or an A or anything like that.  

The checklist type thing seems to have stuck in my mind, as being an observation type thing, while they're doing things, to take notes and...  

Interview 3  

... I tend to have a list and make comments about things that they do and stuff just for a personal record.  

We had looked at the booklet [re profiles] and we do take note of those things when we've been writing our descriptive reports. We've been noting the skills just like we have in the language.  

We've actually started a little maths process book just recently because I thought they've got a lot to tell me, and I've never listened to what they've got to tell me before. So now I've got a little book going and I'll say go and do something in there to do with maths when they've finished their work, and they've just started doing that. I talk to them about it and they show me what they can do. They record pictures and symbolic work. Some of them are into sums and large numbers, identifying hundreds, tens and units.  

I guess I'm just a little bit more observant trying to tune into what they're doing and why they're doing it. And I want to more often use checklist type evaluation rather than anything formal, I really shy away from that. Sometimes I do some of that, but I think the whole flavour of the EMIC program was that if you observe the children during the year it's good. And I've found that kind of approach really good in language for completing the profiles, so if the mathematics profiles come out, I think the checklists will be a much better way to go than a formal test because you've got a bit more information, and you can keep adding to it. I like that form of assessment better than any really. Sometimes I work with children one to one or withdraw them if I have someone else to give me that time. I don't remember a lot on assessment from EMIC. It would have been nice if we had some more time, perhaps another one or two sessions to really look at that. But I think I remember that the checklist type approach was mentioned and just observing and watching what was happening and listening. So keeping records like that in maths was new.
<table>
<thead>
<tr>
<th>RESOURCE TYPE</th>
<th>DURING</th>
<th>SCREEN</th>
<th>CLASS</th>
<th>MESS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAMES_1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>GAMES_2</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>GAMES_3</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>GAMES_4</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>19</td>
</tr>
</tbody>
</table>

Notes:
- GAMES_1, GAMES_2, GAMES_3, GAMES_4 are different games.
- Total uses across different categories.
### APPENDIX 10

**Questionnaire data display**

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>RESPONSE</th>
</tr>
</thead>
</table>
| 1. Two important things learnt from E.M.I.C. re: Mathematics teaching. | • Students enjoy 'E.M.I.C.' type activities.  
• 'E.M.I.C.' activities are relevant to students.  
• It can be fun.  
• Awareness of range of approaches teachers can use when teach maths.  
• Maths sessions need not include 'no', 'min', 'geom.' or 'traditional curric. areas'.  
• Changed emphasis in teach of fractions.  
• Activity approach to maths learn is possible and can cover all areas.  
• Variety evaluation (assessment) techniques can be used and are valuable.  
• Maths teach should be based on realistic view of how maths used in everyday living.  
• Students learn most effectively in group activity based cooperative activities.  
• Hands-on approach often.  
• Make maths exp. real - relevant to students. |

<table>
<thead>
<tr>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>P</td>
</tr>
<tr>
<td>JM</td>
</tr>
<tr>
<td>K</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>JT</td>
</tr>
<tr>
<td>JT</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>L</td>
</tr>
</tbody>
</table>

2. One thing re: th. maths continue to find difficult.

* Very particular/specific...

<table>
<thead>
<tr>
<th>RESPONSE</th>
</tr>
</thead>
</table>
| Teaching basic concepts (+, -, x, ÷) within "E.M.I.C. framework".  
• How to tie-up or adapt an E.M.I.C. approach to total maths program (rather than just isolated activities).  
• Deciding how far to move ahead when student not understanding and saying 'no' to scope of eq...  
• Appropriate evaluation (assessment).  
• Monitoring each student's level of understanding and progress.  
• Prep content not 'meaty' enough - sometimes trivial... |

<table>
<thead>
<tr>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
</tr>
<tr>
<td>JM</td>
</tr>
<tr>
<td>K</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>JT</td>
</tr>
<tr>
<td>L</td>
</tr>
</tbody>
</table>
### Participant Questionnaire cont.

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>RESPONSE</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Need more info about maths th.?</td>
<td>• Expected goals / levels of performance of students in dif grades.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>• Tying up or adapting EMIC approach to 'total maths program' [B2]</td>
<td>JM</td>
</tr>
<tr>
<td></td>
<td>• Method and content of maths th. of years 7 &amp; 8.</td>
<td>K</td>
</tr>
<tr>
<td></td>
<td>• How to integrate maths into all areas of curriculum.</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>• Practical, 'everyday based' activities relating to work on fractions.</td>
<td>JT</td>
</tr>
<tr>
<td></td>
<td>• Practical simple equipment ideas.</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>• More ideas from other teachers.</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>• A checklist/profile with zone development guidelines to check off.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>RESPONSE</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Current feelings re. maths th.</td>
<td>11 (not included)</td>
<td>D, JM, K, C, JT, L</td>
</tr>
<tr>
<td></td>
<td>a) interested</td>
<td>D, JM, K, C, JT, L</td>
</tr>
<tr>
<td></td>
<td>b) relaxed</td>
<td>JT</td>
</tr>
<tr>
<td></td>
<td>c) worried</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>d) successful</td>
<td>C, JT</td>
</tr>
<tr>
<td></td>
<td>e) confused</td>
<td></td>
</tr>
<tr>
<td></td>
<td>f) happy</td>
<td>JT</td>
</tr>
<tr>
<td></td>
<td>g) bored</td>
<td></td>
</tr>
<tr>
<td></td>
<td>h) rushed</td>
<td>D, L</td>
</tr>
<tr>
<td></td>
<td>i) frustrated</td>
<td>JM, C, L</td>
</tr>
<tr>
<td></td>
<td>j) other</td>
<td></td>
</tr>
<tr>
<td></td>
<td>anxious</td>
<td>D, JM,</td>
</tr>
<tr>
<td></td>
<td>satisfied</td>
<td>JT</td>
</tr>
<tr>
<td></td>
<td>+ challenged</td>
<td>L</td>
</tr>
</tbody>
</table>

C* = re 'frustrated'

"It is now the end of the year and I am concerned to make a proper balance of pure, applied, problem solving, logic etc. for next year."
**Participant Questionnaire**

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>RESPONSE</th>
<th>FREQUENCY</th>
</tr>
</thead>
</table>
| 5. Biggest worry affecting maths tech. amenity. | Students have not reached satisfactory standard.  
"Having everything 'Heal-in' [beautifize]  
Finding balance between positive/fun enjoyable maths activities and tech basic processes/computational skills...  
To appropriately incorporate all maths areas into a sequential developmental balance process maths with activity maths and teaching of skills (basic) in one program.  
Logistics - Time to complete activities,  
Ensuring all skills and areas in maths 'thrive' [beautify] for its covered  
Providing balanced program adequate for individual needs. | D (1)  
J (1)  
K (1)  
C (1)  
L (1) |
| 6. How could your maths tech. be improved? | Take maths lessons that start with "formalised work" then illustrate with "hands-on style activities".  
Better organisational skills.  
Consulting someone (e.g. tutor) to find "some direction for myself".  
Teaching approach strategy - Launch into maths projects and find how effectively this form of learning covers the scope of year level learning expectations.  
Planning - Initially to sequentially organise content in a 'thematic way' at the beginning of each term with whole year overview.  
Further ideas on cooperative learning activities to relate to current themes.  
Resource - More time for planning.  
More time to devolve other techs.  
More time to observe students in relaxed way removed from teaching constraints. (Deal with fewer students and have more assistants with non-Eng speakers). | D (1)  
B (1)  
J (1)  
K (1)  
C (1)  
L (1)  
L (1)  
L (1) |
# View Analysis: Teaching Strategies

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Salient Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Schedule</em></td>
<td>浮现时间</td>
</tr>
<tr>
<td><em>Independence or in groups</em></td>
<td></td>
</tr>
<tr>
<td><em>Value</em></td>
<td>相对优点</td>
</tr>
<tr>
<td><em>Value</em></td>
<td>相对优点</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Strategies</th>
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<tbody>
<tr>
<td><em>Enjoyment</em></td>
<td>他们有一个美好的</td>
</tr>
<tr>
<td><em>Enjoyment</em></td>
<td>他们有一个美好的</td>
</tr>
<tr>
<td><em>Existence</em></td>
<td>存在</td>
</tr>
<tr>
<td><em>Existence</em></td>
<td>存在</td>
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<thead>
<tr>
<th>Strategies</th>
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<tbody>
<tr>
<td><em>Change in Methods</em></td>
<td>我用小组和小组</td>
</tr>
<tr>
<td><em>Change in Methods</em></td>
<td>我用小组和小组</td>
</tr>
<tr>
<td><em>Evolution</em></td>
<td>一切都在改变</td>
</tr>
<tr>
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<td>一切都在改变</td>
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<td>学生积极参与</td>
</tr>
<tr>
<td><em>Active involvement</em></td>
<td>学生积极参与</td>
</tr>
<tr>
<td><em>Positive results</em></td>
<td>积极的结果</td>
</tr>
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<td>积极的结果</td>
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</tr>
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<td>积极的结果</td>
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<tr>
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<tr>
<td><em>Positive results</em></td>
<td>积极的结果</td>
</tr>
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<td><em>Positive results</em></td>
<td>积极的结果</td>
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</tr>
<tr>
<td><em>Active involvement</em></td>
<td>学生积极参与</td>
</tr>
<tr>
<td><em>Positive results</em></td>
<td>积极的结果</td>
</tr>
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<tr>
<td><em>Active involvement</em></td>
<td>学生积极参与</td>
</tr>
<tr>
<td><em>Positive results</em></td>
<td>积极的结果</td>
</tr>
<tr>
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</tr>
<tr>
<td><em>Positive results</em></td>
<td>积极的结果</td>
</tr>
<tr>
<td><em>Positive results</em></td>
<td>积极的结果</td>
</tr>
</tbody>
</table>

---

**Appendix 11**

Interview data display: Teaching Strategies—Alan

### Alan

- **Question:** How to incorporate computer use into real life activities? (E) How are expectations of intb 2? (E) Do you want to learn more about 1ife? (E)

---

*Note: The table and diagram are not fully transcribed due to the nature of the handwritten content.*
<table>
<thead>
<tr>
<th>Alan</th>
<th>&quot;different kinds of course&quot;</th>
<th>&quot;effective teaching materials&quot;</th>
<th>Cathy [EMIC tutor]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;extensive of resources&quot;</td>
<td>&quot;concrete materials&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;fraction lute&quot;</td>
<td>&quot;textbooks&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;maths books&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>teacher: my biggest reason is having Cathy in the school</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>changes: I'm still using anything that I can find having Cathy is working with me</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>substitute: it's different</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>self: I find it more easy one and work through</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>teacher: I'm more likely to go in search... and look through to see if there's anything that might be of help to what I'm actually doing. So, I'm working in the opposite direction... I think, coming from a different place</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>teacher: influence EMIC</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Cathy: giving more concrete materials in maths now as a result of my doing that EMIC</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>teacher: resource person</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Cathy: an increase in resource use</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>teacher: consistent reference to Cathy as a valued resource</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Interview Analysis: Assessment Strategies

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Strategies</th>
<th>Salient Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anne</td>
<td>&quot;not very formal&quot;</td>
<td>&quot;I'm thinking and I watch... anecdotal records, that sort of thing&quot;</td>
</tr>
<tr>
<td></td>
<td>(none reported)</td>
<td>(none reported)</td>
</tr>
<tr>
<td>Alan</td>
<td>&quot;be careful not to overuse...</td>
<td>&quot;I've realized that the only thing we do is test...&quot;</td>
</tr>
<tr>
<td></td>
<td>(none reported)</td>
<td>(none reported)</td>
</tr>
<tr>
<td>Zach</td>
<td>&quot;normal sort of testing&quot;</td>
<td>&quot;I've been thinking about how to make it more formal...&quot;</td>
</tr>
</tbody>
</table>

**Interview Data Display:**

- **Interview:** Assessment Strategies - Alan
- **Notes:**
  - Do show all of the descriptives used in the analysis.
  - Pay attention to the level of confidence in the assessment methods and the influence of external factors.
  - Note any significant shifts in approach and reassessment.
  - Consider the influence of external factors on the assessment process.
  - Focus on the relationship between assessment techniques and student outcomes.
# Interview Analysis: Professional Attributes - Alan

## Confidence

<table>
<thead>
<tr>
<th>Reactions</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>+growth in confidence reported</td>
<td></td>
</tr>
</tbody>
</table>

- +assistance/support: "there's people, I've got a lot going on..." and energy boosts (EMC) boost confidence...
- +sharing: "sharing ideas with other people... I've said I and I work really closely with..."
- +school context: "I think there could be more coordination in organizing and planning... we do it..."
- +sharing: "I don't think there's enough of that kind of thing... it's just sharing ideas and stuff..."
- +school context: "there's a lot of sharing... it happens all the time..."
- +student change: "I'm happier than I was... and that's what it all about... and their attitude towards..."

## Calligability

<table>
<thead>
<tr>
<th>Reactions</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>+growth in confidence reported</td>
<td></td>
</tr>
</tbody>
</table>

- +assistance/support: "there's people, I've got a lot..."
- +sharing: "sharing ideas with other people... I've said I and I work really closely with..."
- +school context: "we do it..."
- +sharing: "I don't think there's enough of that kind of thing... it's just sharing ideas and stuff..."
- +school context: "there's a lot of sharing... it happens all the time..."
- +student change: "I'm happier than I was... and that's what it all about... and their attitude towards..."

## Attitude

<table>
<thead>
<tr>
<th>Reactions</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>+greater satisfaction with own approach reported</td>
<td>+more positive</td>
</tr>
</tbody>
</table>

- +innovative techniques tried: "it was really good... it was because..."
- +changes: "they're [students] more interested in participating..."
- +innovative techniques tried: "it was really good..."
- +changes: "they're [students] more interested in participating..."
- +innovative techniques tried: "it was really good..."
- +changes: "they're [students] more interested in participating..."
- +innovative techniques tried: "it was really good..."
- +changes: "they're [students] more interested in participating..."

## Experimentation

<table>
<thead>
<tr>
<th>Reactions</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>+appears satisfied with amount of experimentation throughout programs and following it</td>
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</tr>
</tbody>
</table>

- +innovative techniques tried: "I did nearly all of these activities in here [EMC bells...]
- +student change: "(I) have a really good..."
- +innovative techniques tried: "I had a really good..."
- +student change: "(I) have a really good..."
- +innovative techniques tried: "I had a really good..."
- +student change: "(I) have a really good..."
- +innovative techniques tried: "I had a really good..."
- +student change: "(I) have a really good..."

## Reflection

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<td>+appears consistent with what has been learnt (at least at this stage, 16-12SEA)</td>
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- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."

## Learning

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- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."

## Empowerment

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- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
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- +innovative techniques tried: "(I) really enjoyed..."
- +innovative techniques tried: "(I) really enjoyed..."
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<th>Pedagogical Knowledge</th>
<th>Interpersonal Skills</th>
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<tbody>
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<tr>
<td><strong>Reflectiveness</strong></td>
<td>- Effective teaching needs to be...</td>
<td></td>
</tr>
<tr>
<td><strong>Efficacy</strong></td>
<td>- Reflects on BDC meeting needs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- &quot;It really opened my eyes—&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- &quot;I realized that math is really...</td>
<td></td>
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<tr>
<td></td>
<td>- &quot;what I thought it to be. It was the approach through...</td>
<td></td>
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<td></td>
<td>- &quot;reflects BDC&quot;</td>
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<tr>
<td></td>
<td>- &quot;my teaching methods have changed...&quot;</td>
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<tr>
<td></td>
<td>- &quot;I was pretty much...&quot;</td>
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<td></td>
<td>- &quot;the whole approach towards teaching math&quot;</td>
<td></td>
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<td></td>
<td>- &quot;are still skills that...&quot;</td>
<td></td>
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<td></td>
<td>- &quot;still need to be actuated, and that still needs to be actuated, but let's use...&quot;</td>
<td></td>
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<tr>
<td></td>
<td>- &quot;new strategies&quot;</td>
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<td></td>
<td>- &quot;are trying to get the kids involved more...&quot;</td>
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<td>- &quot;characteristics of the book and...&quot;</td>
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<td>- &quot;essentially physical...&quot;</td>
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<td></td>
<td>- &quot;and allowing discussion...&quot;</td>
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<td>- &quot;we've used mathematics, and just...&quot;</td>
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<td></td>
<td>- &quot;something to take the stress off the book and the...&quot;</td>
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<td>- &quot;and just be doing&quot;</td>
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<td></td>
<td>- &quot;changed use resources&quot;</td>
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<tr>
<td></td>
<td>- &quot;the kids are using more concrete materials in...&quot;</td>
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<td>- &quot;as a result of me doing that...&quot;</td>
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<td>- &quot;I've tried to incorporate a couple of math books...&quot;</td>
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<td></td>
<td>- &quot;I tend to start at page one and...&quot;</td>
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<td></td>
<td>- &quot;I'm more likely to go...&quot;</td>
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<td>- &quot;to me this is...&quot;</td>
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<td></td>
<td>- &quot;and what I'm doing...&quot;</td>
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<td></td>
<td>- &quot;in the opposite direction...&quot;</td>
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<tr>
<td></td>
<td>- &quot;I think coming from a different place...&quot;</td>
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<tr>
<td></td>
<td>- &quot;changes&quot;</td>
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<tr>
<td></td>
<td>- &quot;we're doing a totally integrated program now...&quot;</td>
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<tr>
<td></td>
<td>- &quot;we're not sort of having everything...&quot;</td>
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<tr>
<td></td>
<td>- &quot;in a format like it used to be...&quot;</td>
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<td>- &quot;When I first spoke to you I was always...&quot;</td>
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<tr>
<td></td>
<td>- &quot;my math teaching was always very formal...&quot;</td>
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<tr>
<td></td>
<td>- &quot;I've learnt there are...&quot;</td>
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<tr>
<td></td>
<td>- &quot;better ways and more interesting ways...&quot;</td>
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<td></td>
<td>- &quot;every year and then I find it necessary to take a different approach...&quot;</td>
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<tr>
<td></td>
<td>- &quot;I don't think there's anything...&quot;</td>
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<td>- &quot;I'm always looking for practical means...&quot;</td>
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<td></td>
<td>- &quot;then I use this in...&quot;</td>
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<td></td>
<td>- &quot;making sure that I use...&quot;</td>
<td></td>
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<tr>
<td></td>
<td>- &quot;the kids enjoy and benefit from...&quot;</td>
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<tr>
<td></td>
<td>- &quot;it's not all teacher directed...&quot;</td>
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<td>- &quot;there's more self discovery...&quot;</td>
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<td>- &quot;and sharing...&quot;</td>
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<td></td>
<td>- &quot;making sure that I use...&quot;</td>
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<td></td>
<td>- &quot;group work and things like...&quot;</td>
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<td></td>
<td>- &quot;it does make a difference...&quot;</td>
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<td></td>
<td>- &quot;putting 30 problems up on the board...&quot;</td>
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<td>- &quot;and saying open your books and go for it, so it's...&quot;</td>
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<tr>
<td></td>
<td>- &quot;in a different place...&quot;</td>
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<tr>
<td></td>
<td>- &quot;a whole lot of different things...&quot;</td>
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<tr>
<td></td>
<td>- &quot;make math more interesting...&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- &quot;changes&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- &quot;the kids doing, and...&quot;</td>
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<tr>
<td></td>
<td>- &quot;not me telling them...&quot;</td>
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<tr>
<td></td>
<td>- &quot;what they're supposed to be doing...&quot;</td>
<td></td>
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<tr>
<td></td>
<td>- &quot;I mean, I gave them the opportunity...&quot;</td>
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<td></td>
<td>- &quot;and there is a lot more...&quot;</td>
<td></td>
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<tr>
<td></td>
<td>- &quot;and I mean that they...&quot;</td>
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<tr>
<td></td>
<td>- &quot;if I know it's not...&quot;</td>
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APPENDIX 15

INTANALYSIS 1
Interview data display: Characteristics of the professional development program perceived as influencing growth—All teachers

### Q2: PD CHARACTERISTICS (CLUSTERED)

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Description</th>
<th>Example Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component 1</td>
<td>Reflection</td>
<td>&quot;I believe it made me think about different things...&quot;</td>
</tr>
<tr>
<td>Component 2</td>
<td>Participation</td>
<td>&quot;Lots of different teachers joining in...&quot;</td>
</tr>
<tr>
<td>Component 3</td>
<td>Knowledge Transfer</td>
<td>&quot;Good to have new ideas...&quot;</td>
</tr>
</tbody>
</table>

### Q3: PD CHAR. 1

<table>
<thead>
<tr>
<th>Content</th>
<th>Description</th>
<th>Example Statements</th>
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</thead>
<tbody>
<tr>
<td>Knowledge Transfer</td>
<td></td>
<td>&quot;...&quot;</td>
</tr>
<tr>
<td>Participation</td>
<td></td>
<td>&quot;...&quot;</td>
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</table>

### Q4: PD CHAR. 2

<table>
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<tr>
<th>Program Area</th>
<th>Description</th>
<th>Example Statements</th>
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</thead>
<tbody>
<tr>
<td>Generation and Implementation</td>
<td></td>
<td>&quot;...&quot;</td>
</tr>
<tr>
<td>Improved teachers</td>
<td></td>
<td>&quot;...&quot;</td>
</tr>
</tbody>
</table>

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*Note: The table continues with similar entries and descriptions.*
<table>
<thead>
<tr>
<th>Column comments (left)</th>
<th>Column comments (right)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General:</td>
<td>General:</td>
</tr>
<tr>
<td>change time structure;</td>
<td>follow up/refresher</td>
</tr>
<tr>
<td>other night classes or</td>
<td>(G31, P3, G4A, 3, 4A7)</td>
</tr>
<tr>
<td>20 workshops to three to</td>
<td>follow up with same</td>
</tr>
<tr>
<td>four days (G7)</td>
<td>teacher (G2, J5, 87)</td>
</tr>
<tr>
<td>[programmed]</td>
<td>further training at</td>
</tr>
<tr>
<td>whole school involvement (G7)</td>
<td>later time (G31)</td>
</tr>
<tr>
<td></td>
<td>similar program to ShMC in 5 years - same</td>
</tr>
<tr>
<td></td>
<td>format (33)</td>
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<tr>
<td>Personal:</td>
<td>Personal:</td>
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<tr>
<td>specific information/</td>
<td>specific information/</td>
</tr>
<tr>
<td>feedback</td>
<td>feedback</td>
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<tr>
<td>more or course planning (G31)</td>
<td>more or course planning of (G31)</td>
</tr>
<tr>
<td>focus on government policy documents needed (G31)</td>
<td>focus on government policy documents needed (G31)</td>
</tr>
<tr>
<td>more activities for younger this (37)</td>
<td>more activities for younger this (37)</td>
</tr>
<tr>
<td>more assessments particularly diagnostic assessment (G7)</td>
<td>more assessments particularly diagnostic assessment (G7)</td>
</tr>
<tr>
<td>[arranged]</td>
<td>[arranged]</td>
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<tr>
<td>[a] It still would have liked less more practical help. (G31)</td>
<td>[a] It still would have liked less more practical help. (G31)</td>
</tr>
</tbody>
</table>

**Recommendations re pd program**

- Change time structure; other night classes or four 20 workshops to three to four days (G7)
- Whole school involvement needed (G7)
- Specific information/feedback
- More or course planning (G31)
- Focus on government policy documents needed (G31)
- More activities for younger this (37)
- More assessments particularly diagnostic assessment (G7)
- [Arranged] (G31)
- [a] It still would have liked less more practical help. (G31)
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*Note: The table continues with similar entries.*
Observation data display: Teaching Strategies—All teachers

### Observation Analysis: Teaching Strategies

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<tr>
<th>Teachers</th>
<th>Whole class</th>
<th>Group</th>
<th>Individual</th>
<th>Cooperative group</th>
<th>Individual ACT</th>
<th>Whole class ACT</th>
<th>Total</th>
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<td>B</td>
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<td>3</td>
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<td>5</td>
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<tr>
<td>C</td>
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<td>1</td>
<td>3</td>
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### NATURAL ACTS

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<th>ACTS</th>
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<tbody>
<tr>
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<tr>
<td>B</td>
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<tr>
<td>C</td>
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### RECOGNIZED ACTS

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<tbody>
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</tr>
<tr>
<td>C</td>
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</table>
Observation data display: Resource Use—All teachers

**Observation Analysis: Use of Resources**

| RESOURCE                        | P   | G   | H   | GE  | CA | R   | P   | G   | H   | GE  | CA | R   | P   | G   | H   | GE  | CA | R   | P   | G   | H   | GE  | CA | R   |
|---------------------------------|-----|-----|-----|-----|----|-----|-----|-----|-----|-----|----|-----|-----|-----|-----|-----|----|-----|-----|-----|-----|-----|
| Map                             |     | 35  |     |     |    |     |     |     | 85  |     |     |     | 4   |     | 5   |     |    |     |     |     |     |     |
| Wall                            |     |     |     |     |    |     |     |     |     |     |     |     |     |     |     |     |    |     |     |     |     |     |
| Whiteboards                     |     |     |     |     |    |     |     |     |     |     |     |     |     |     |     |     |    |     |     |     |     |     |
| Overhead                        |     |     |     |     |    |     |     |     |     |     |     |     |     |     |     |     |    |     |     |     |     |     |
| Plastic                         |     |     |     |     |    |     |     |     |     |     |     |     |     |     |     |     |    |     |     |     |     |     |
| Paper                           |     |     |     |     |    |     |     |     |     |     |     |     |     |     |     |     |    |     |     |     |     |     |
| Graph paper                     |     |     |     |     |    |     |     |     |     |     |     |     |     |     |     |     |    |     |     |     |     |     |
| Other                           |     |     |     |     |    |     |     |     |     |     |     |     |     |     |     |     |    |     |     |     |     |     |
| **Total**                       |     |     |     |     |    |     |     |     |     |     |     |     |     |     |     |     |    |     |     |     |     |     |

**Note:** The table above illustrates the use of various resources in a classroom setting. The numbers indicate the frequency or duration of use for each resource across different categories (P=Primary, G=General, H=High, GE=General Education, CA=Creative Arts, R=Recreation). The specific values and their context are not provided in the image.
Observation data display: Assessment Strategies—All teachers

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<th>Observation</th>
<th>Assessment</th>
<th>Analysis</th>
<th>Assessment</th>
<th>Strategies</th>
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## CROSS DATA ANALYSIS: TEACHING STRATEGIES

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### Notes
- NO Whole Class Active OBS
- Mix G/P/I/10D
- High Use Discussion & Explanation Throughout (6/7)
- Only Discussion OBS
- Mix Task Types; NO Dev MTT
- Med Use Games 6A +10-12 (8/5)
- Insp MTT OBS / 10F (3)
- Class Tech Only OBS

Interview and questionnaire references:
- **= Discussed in detail**
- * = Referred to
- * = Not mentioned

---

CDANAL: TS: OB 1
## Cross Data Analysis: Use of Resources

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<td>O&amp;O + simulation</td>
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<td>O&amp;O + activity book</td>
<td>O&amp;O + worksheet</td>
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Interview and questionnaires references:  
* = Discussed in detail  
o = Referred to  
x = Not mentioned

- **High Use**: High Use  
- **Little Use**: Little Use  
- **Not Used**: Not Used  
- **High Use MATLEY**: High Use MATLEY

**Appendix 21**

Multi-data-source display: Alan—Resource Use
### Cross Data Analysis: Assessment Strategies

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**Assess Record Type**

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**Notes**

- Obs & Int/Quest = Obs Events
- Anecdotal, High Use = Only Anecdotal, High Use
- Int/Quest = Obs Events = Anecdotal, High Use
- Other Obs = Tests & Int/Quest & Checklist

**Interview and Questionnaire References**

- Discussed in detail
- Referred to
- Not mentioned

- Have a go

- Meet candidate
- In family
- Building to discuss
- Build up to conclude
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<th>SA</th>
<th>10-12 MA</th>
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**Notes:**
- May not have many DUR sequences every way - no clear data - don't have DUR data - could do school activities - no clear data in relation to this area - own data.
- Possible to intuit broad change environment discussion in relation to this area.
- Could have own data.

**Change sequences display: Teaching Strategies**

**Appendix 23**

**Salient features**
- "Fun" - student participation; interaction.
- "Enthusiasm" - student involvement.

**Salient features**
- Lack of teacher expertise/teacher support.
- "Approval" - approval of teaching methodology.
- "Approval" - approval of teaching strategy.

**Salient features**
- Setting "ideal" - strong emphasis.
Change sequences display: Resource Use
Change sequences display: Assessment Strategies
Questionnaire related to your role as an EDCM tutor

1. Describe how you see your role as an EDCM tutor.

As an EDCM tutor, I see my role in two parts: a support role for the participants of the program, and an active role in the classroom. In the support role, my goal is to be available as a source of information and to help participants understand the material. I try to be approachable and provide guidance and support whenever possible. In the classroom, I try to be active and engaged with the students. I believe that my role is to facilitate learning and to help students develop their critical thinking skills.

2. What do you consider the positive features of your style of teaching in the classroom setting?

My style as an EDCM tutor is one that emphasizes engagement and collaboration. I believe that active learning is the key to effective teaching. I try to involve students in discussions and encourage them to think critically about the material. I also use a variety of teaching techniques, such as group work and problem-solving, to keep students engaged.

3. How might your style of working as an EDCM tutor differ from other teachers?

I think my style of teaching is similar to that of other teachers, but I focus more on engagement and collaboration. I believe that these two elements are crucial for effective teaching, and I try to incorporate them into my lessons. I also try to be flexible and adapt my teaching style to the needs of my students.
4. What factors outside your control do you believe influence your effectiveness as an ESL teacher?

I'm interested to think about what were the factors outside my control that influenced my effectiveness as an ESL teacher. I'd love to be able to say that the weather was always good and it wasn't anything-like that. I can't think of anything that was outside my control because I felt very much in control of my programs.

Perhaps the fact that the participants at that time when I was going through the ESL program came from schools nearby and I knew a lot of them and I found it very easy to build up a rapport of skills and things with people that I knew. But later I found that because I was quite willing to travel anywhere, I would quite well known people and people would seek me out and ask me whatever and you come and do this or that and I don't do this but I did it down in Beaconsfield, right out of my own areas. And sometimes I would get a bit out of my control and I would set people right and not that people were right. Other than that, not really. I can't think that there were any factors outside of my control.

Perhaps the fact that my principles were always very, very supportive of my programs and schools and went out of their way to help me and the programs. And my staff were always wonderful. They always closed out of the classroom or out of the library or wherever so that I could use it, and I don't think that was out of my control. Everybody was very supportive of me as I did my programs and everybody was really good.

Questions related to the ESLIC program in general:

5. What do you think are the key elements of the ESLIC program?

I think the thing that pleased people the most, and certainly did me, was the idea of not forcing the baby out of the bath water, of keeping the old that was good and well tried and accepted and then that part of the program, TVIP, I felt impressed people as great deal, and I knew it then and I found that that was, indeed, gives teachers good confidence that they were doing right thing but there were other things they could do. And in itself was to the key thing and in taking the baby out of the bath is keeping the old and adding to that and then bringing into that of the newer principles, the particular principles of understanding that make a difference in the classroom or in schools and universities. This school makes a real difference and I think set people off with a bang and that was one of the key elements.

6. The other key element of course is the following on your teaching style and children's learning style. The great thing is that a program like ESLIC does, in fact, allows teachers to sit with a lot of other teachers and talk about how you teach English. Then or how your children learn English, or that some children can't cope with the freedom of a workshop approach. Helping teachers to find ways to do so, to be actively involved in their teaching but not getting around the room.

I must admit that having half-day now for nine months it's a little hard for me to think of all the things, but I know that there are the things that vary very sharply to things, as I sit here in England away from it.

6. Do you see the ESLIC program as successful?

Oh, yes. I must say that I believe it brought about the most wonderful change in the mindbend. I know when I first started to do it the sort of things that were going on in classrooms, because if you as one of the people was doing that sort of thing, I mean, the change that ESLIC brought around by allowing teachers to change together was wonderful. People used to come up to me all the time and say, I did the thing from ESLIC or I'm doing that thing from ESLIC and realize that they were doing lots of things from ESLIC. It bubbled over into the publishing world. I know that produce were more of the sort of things that I was forever having publishers and people knocking on the door to try to sell them to you, and they very quickly caught on the identity behind ESLIC and realized, I'm just trying to think, but a lot of the publishers would come to me and say, but this is in ESLIC, this is in ESLIC, you must buy this program because we've adopted these things because they're in ESLIC. It becomes, in Victoria, especially the key word for me was that good. People were always saying to me since. I did ESLIC this has been so much better for me. I just know that teachers that I was in it realized that to make it with them. Programmes more acceptable to them as teachers and still keep the parents happy that we're undertaking a serious math program and that it was the best that we could possibly offer our children. I just believe that it was, with ESLIC, one of the great features of Victorian state education, and I can't be more sorry for people who didn't send their teachers along and allow this sort of new change to take place. I certainly think it was successful.

I think the reason for its great success of course was the model, this supported change, supported learning. The idea of coming each week, of having a break between some units, of having tasks to do when you're away from the program. I think that is why it was so successful. I think there was a responsibility as a participant just like there was a responsibility from the teachers and you who wanted to be involved in the program. I think the model that made it so successful, the model that it is ESLIC. I'm sure that's the key to it, supported change. I think you can go on to one off programs and come away every confident that you've learnt anything or that you can make any great change. I mean, and I don't know that I think it's what it's all about. I think it's just this reflection on your program. I'm sure there are people who came to ESLIC very much interested in the ideas that were presented, but the program became a success in that because it gave rise to the beliefs and attitudes that after the ten weeks.

7. Of the six teachers I worked with, (Diana, John, Kevin, Caroline, Julie and Lisa), who do you consider benefited the most, and the least?

I think it's very interesting and I've thought a lot about who benefited the most and who benefited the least.

I know for people like LCN it was giving her, it was exactly where she was coming from and all of a sudden here was all the things that she believed written down and given as the gospel

I think it's very interesting and I've thought a lot about who benefited the most and who benefited the least.
truth and I think that that allowed her to see very clearly into something that she believed to be very true. So, if you say who benefited the most well perhaps it's the people in the audience who benefited the most.

Q17: I didn't know very well, so I didn't really know that it was going to have such a great impact on her.

Q18: The other hand, was very enthusiastic about everything. And when she went to EBC I thought she never missed a chance to share her enthusiasm for that which was not true, so for her it was a great thing too.

Q19: I've been going for years and years, and he was always quite an enthusiastic person about everything he was talking about. He was a very engaging speaker, he kept up with everything. I don't know whether you'd say that he benefited the most.

Q20: I don't think anyone in that group, who I meant, I worked very closely with EBC, but when he first came to be frightened by the situation and then he was really new. He was just a new editor, and he was very, very keen. He thought that because of his extensive background in psychology that children were going to learn, and that learnt was very much to me, just a great accomplishment. I was frightened at first but then he managed to stay. I think it was because he was motivated, I think he was an interesting one too. EBC is in the stem and stern. You know, she can be in her element with children and yet she's also in the right way of doing things as she says very very clearly. I think she's a very special person who benefited a great deal.

Q21: I wonder how you measure this. Do you measure it as an individual, what did they get out of it, or do you measure it as a group? I think, particularly my group, at EBC, I can't, well I don't really know. I think a lot of our people are measured by the success of the programme, but if the children are learning and if they're enjoying themselves, that's what they're enjoying, that's what they're doing.

Q22: I think I would measure it in a sense from someone to someone. I really do. I think that that was the most important thing that happened, I think it was one of the highlights of the programme that had a lot of impact.

Q23: It's the whole school, or the people who work with, which is the thing that EBC needs to be somewhere else put the idea that you're better at being than on your own. I don't know how, but I feel that there is a lot. I think that EBC and EBC became part of the school, they started to be part of the school, and I think that EBC started to be part of the programme and I think it was the best of both.

Q24: That's what it means to me because I know how much people learn from these experiences, and I'm not so much in that programme did a lot of this.

Q25: I've been out of the programme for ten years now, but I still think of it as a very important part of my professional development. I think that this was the most important thing that happened, and it was the most important thing that happened in the whole programme.

Q26: I think that it's very important to me because I know how much people learn from these experiences, and I'm not so much in that programme did a lot of this.
much out of it as grade six. Whether they were in the art room or not depended entirely on the individual. I had people who had been in the art room for years and did BMIC and made became part of the art room. I think that it is important to make things where she had seen something mathematical going on in her child's art work and feel something about it. So it didn't really matter whether you were the physics specialist or the art specialist; it was whether or not you were open to the exchange of ideas, whatever you came because you wanted it, whether you felt some sort of support with the tutor, and the other people in the group, and whether your staff was at a time or at a place where the morale was really good. I'm sure these are the things that mattered.

5. Could you describe other professional development programs you have been involved with?

In your opinion, what are the similarities and differences between BMIC and these programs, both in terms of the structure of the programs and their relative success?

Well, I've been teaching a long time and I've been a part of a wide range of things. I remember in 1970 going to the Advic Arts workshop in 1970, and all we went to another school to hear about the introduction of the new science course and that just did the day after the seminar. Apart from that I had in the television and the off site and it was very new to have a big inservice like this. It was a disaster.

I think about BMIC, the structure of the program, the support during change. I've called it that it is still wonderful. BMIC, then BMIC, TIC, etc., were the same sort of thing, and I know that in my last few years in Victoria I really saw these elements of BMIC, BMIC, TIC, CLIP, etc., become part of the every day teaching and training strategies of schools, and of teachers that I know that were not necessarily in those schools. BMIC to a lesser extent, the Family Links program didn't start in the early change, but in the middle, because the change wasn't supported over a great deal of time, for every school it tended to peter out. And yet when I was involved in the family science program on the other hand, they did attempt to keep it going by having really not so much 'revolutions', but having follow-up workshops. That was a great change. That was one of the things I liked to do in BMIC too, was to have little sessions every year where people from my formative school would come back and talk every time that they would come across new things that they wanted to use, and spend a bit of time considering together. I think that's important in the change that was that change, that made everything so successful.

I think too another important part was the level of tutor involvement. That sounds like a funny thing to say, but I think it was in all of these things, you know in BMIC and everything like that, my CV made as an alphabet, but a lot of them, the locals would not be participants in their own planning. They tended to do the things like I'd like you to discuss such and such and then tell me about it, and then the tutor would refer to the other side of the room and start up there. I know that in every single course where that happened there was a degree of success, and the participants resisted the tutors removing themselves from the group. The tutor who was set in on groups and because part of the discussion as that they were affected involved rather than just sitting on the sidelines and looking at participants. That was another thing that I always felt the exchange of these BMIC groups was a great deal of time in the first few years of it getting together from time to time and reflecting on their programs. I mean apart from the fact that they used to be great fun, I think it was wonderful to combine my program with other programs, and that helped it all make sure that your program was appropriate.

Such things as the length of the program. I don't think of a lot of them were successful even though they were long. I mean BMIC was a bit shorter. I think it was only seven or six, the others were ten and ten, I think. Some people combined down into eight units. I didn't think that was really mattered. I think the fact that each particular unit was very well put together was wonderful. That would have been a criterion. I might have had of TIC, that sometimes there wasn't enough mean in a particular unit, but the whole thing idea of trying an activity, going away, having some sort of activity to do between the units. That was such a good model, I'm just sure it is.

Questions related to professional development in general:

10. What do you think are the criteria for effective professional development programs?

Firstly, it seems that we must be able to effectively these programs, they have to be able to convince us that they are going to be a success and that we will be able to do them again. I think that BMIC was great at the very beginning when teachers got off half an hour early to come to BMIC so that we could start at three. That really made them feel that they were getting something for going. I think too as I said before that active workshops for teachers are much, much more enjoyable than going to talk or seminar type thing. I think teachers like to be up and at it and trying the very thing they are going to use with their children, and professional development programs for teachers need to be in that sort of active mode.

I think they need to be spaced out over a considerable time. I don't think teachers mind coming for ten weeks, I mean they complete but if they're getting a lot out of it, if they're happy to come back the next time, try something, talk about it, try something.
11. How would you evaluate the success of a professional development program?

Well I think about this one a lot. Because you can see, perhaps not immediately but certainly years later how effective some professional development programs have been, but in a very good example of this. I mean if you were to look now at five or six years down the track of the effect of a professional development program that was widely accepted as say BSE was, you can see the key elements of the program became accepted elements of teaching practice in Victoria. Well they have, you see elements of BSE in every school in Victoria, you really do.

Do teachers whom they talk amongst another release those elements? Are they saying the same things that we were putting across in BSE? Have they forgotten because they’ve taken it on board so naturally that once they didn’t do? Has it become so much a part of them?

And I’m not sure for years ages or eight ages when BSE was very new, it was unusual for people to be talking in great depth about their practice programs, and you’d hear it all the time, ways that people have adapted BSE ideas and they’ve forgotten that maybe five or six a year ago they were struggling around with Young Australian Babies before it came along and pulled it all together they were struggling along to try to get a good program, and now where BSE is they are able to do it themselves.

Has it spread? Has it moved beyond just the people who actually participated in the program? Has it spread teacher to teacher in a school? Are these teachers at school who haven’t actually participated in the program who have adopted elements of it? Has it moved from department to department in schools, or school to school?

Is the sort of things that were presented in the professional development program being reflected in professional reading? Does classroom magazine talk about it, does this magazine and that magazine?

And the other thing of course I think that the success of a professional development program is if publishers start to take it up and put it into programs that you can buy commercially. I think that’s a very good reflection that the overall program has been a success.

12. Who do you see as the beneficiaries of a professional development program?

Well it’s like I’ve been very clear and say the children first, but actually I don’t think it’s the children first, I think it’s the children in the long run. But I think the beneficiaries of professional development are the teachers themselves, because good professional development in teachers teaches, because good professional development program doesn’t show you ways to improve your classroom. And by good classroom practice I mean you mean effective classroom practice, things where the children are learning, and that’s how and where you have the best practice. And when children are learning well and teachers are happy in their provision of good classroom practice, it is good for the school. Schools become known for their good classroom practice. Children are happy, successful. And then it becomes good for the Directorate as a whole. And when the Directors and schools are happy with their teachers, work’s a success for teacher morale, and good teacher morale itself is good for kids. Because happy teachers really do have an effect on the classroom. I’m very aware of that. And if there are those low morale, teacher morale in the LSC in the state system, and then they are being got at in the press all the time.

Primary teachers in England in the state system are just open to such shocking criticism in the press all the time. I mean we were never party to that. And I am sure over the last few
The Interconnected Model of Teacher Professional Growth
(Teacher Professional Growth Consortium, 1994)

(External Domain)
- External Source of Information
  - Stimulus or Support

(Personal Domain)
- Teacher Knowledge and Beliefs

(Domain of Practice)
- Classroom Experimentation

(Domain of Consequence)
- Salient Outcomes

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