

http://researchcommons.waikato.ac.nz/

Research Commons at the University of Waikato

Copyright Statement:

The digital copy of this thesis is protected by the Copyright Act 1994 (New Zealand).

The thesis may be consulted by you, provided you comply with the provisions of the Act and the following conditions of use:

- Any use you make of these documents or images must be for research or private study purposes only, and you may not make them available to any other person.
- Authors control the copyright of their thesis. You will recognise the author's right to be identified as the author of the thesis, and due acknowledgement will be made to the author where appropriate.
- You will obtain the author's permission before publishing any material from the thesis.

Professional Development of High School Mathematics Teachers

A thesis submitted in fulfilment of
the requirements for the degree of

Doctor of Philosophy

by

Andrew John Cameron Begg



University of Waikato
Te Whare Wānanga O Waikato
1994

ABSTRACT

Mathematics teachers are expected to make changes in what they teach, how they teach, how they assess and how they view the learner. These expectations are impinging on them at the same time as other changes in education and in society. In response to this, teachers, school administrators, teacher educators, curriculum developers and policy makers have all asked for more professional development.

The aim of this study was to find out more about development, what was needed, and how it might be organized to make it effective. The study was undertaken in 1989–1994 which was a time of considerable change for educational administration with delivery systems for teacher development undergoing change and the mathematics curriculum being rewritten. The research initially addressed the questions:

1 What are the professional development needs of high school mathematics teachers?

2 How might these needs best be met?

These led to three further questions:

3 What model(s) for development would be appropriate?

4 What influences affect school-based professional development?

5 Can a teachers guide, incorporating the findings from question 2 help schools with the professional development of mathematics teachers?

The study was based on the assumption that professional development is a form of learning rather than change imposed from outside the learner. It therefore can be viewed as a constructivist process and as part of the ongoing growth of the teacher.

The study involved a review of the literature and policy documents, and research in 14 schools with 14 heads of department, 30 other mathematics teachers, 10 school administrators (principals and curriculum coordinators), and 15 mathematics educators.

The main data collection was by interviews with the teachers, heads of department and school administrators. The data from mathematics educators was obtained through a questionnaire and some additional data was obtained through response sheets which were included in a teachers guide on professional development which was distributed.

The data collected from the teachers, mathematics educators, and policy documents provided overlapping perspectives on the focus for development activities (school, subject, and teacher needs), the types of development activities (in-school, between schools, and individually initiated), and the influencing factors (time, resources feelings, and support). The data reflected a conservative view of 'more of the same' rather than a consideration of alternative strategies for effecting change.

The data from the heads of department in the later part of the research showed what development and planning were occurring. After a teachers guide and the new mathematics curriculum had been distributed to schools, the heads of department were interviewed again to see what was happening and to find whether the teachers guide had been of assistance. Six of the schools were doing in-school work by focusing their department meetings on professional matters but only two of these held regular and frequent (weekly) meetings. The other schools relied largely on external providers for development activities. Overall, in spite of professional development being a component of school charters, very little initiation of development activities originated from twelve of the fourteen schools.

The provision of development activities to help heads of departments gain development leadership skills emerged as the most pressing need. The teachers guide seemed to have virtually no immediate effect—this was not surprising because the provision of new ideas had been previously identified as just one of a number of components that need to be present for effective professional development.

The thesis argues that professional development needs to be ongoing and have a growth focus which builds on strengths and continually seeks improvement rather than a stop-start model that focuses on imposed change or making up for deficits. The control and responsibility for such development of high school mathematics needs to be with the teachers, the heads of department need to provide the leadership, and the location of the main components for development should be in the school. The more specific conclusions were that schools need to plan for this development and upgrade the skills of their heads of department so that the leadership will be provided.

ACKNOWLEDGEMENTS

I would like to thank:

- Colleagues at the Centre for Science and Mathematics Education Research for their help, comments and support, in particular my supervisors, Malcolm Carr, Fred Biddulph, and Valda Kirkwood for their guidance and assistance; Raewyn Oulton, for assistance with transcription, typing and artwork; and Beverley Bell for support and suggestions.

- The Ministry of Education for the contract funds that supported parts of this project in return for two milestone reports.

- The heads of mathematics department, the principals, professional development coordinators, and the mathematics teachers at
  Fairfield College
  Mangakino High School
  Ngaruawahia High School
  Otorohanga College
  Reporoa College
  Western Heights High School
  for assistance with interviews and comments on the teachers guide,

- The heads of mathematics department at
  Green Bay High School
  Huntly College
  Morrinsville College
  Te Awamutu College
  Te Kauwhata College
  Thames High School
  Waihi College
  Whangamata Area School, and
  for assistance with interviews and comments on the teachers guide,

- Mathematics education colleagues (inspectors, advisers and college of education lecturers) who provided information at a time of particular stress due to the restructuring of educational administration.

CONTENTS

	Abstract		ii
	Acknowledgements		iv
	Contents		v
	List of Tables		ix
	List of Figures		ix
PART A	INTRODUCTION		1
Chapter 1	An overview		2
	1.1	Introduction	2
	1.2	Changes in mathematics education	3
	1.3	Changes in educational administration	5
	1.4	Changes in society	6
	1.5	Some consequences of these changes	8
	1.6	Research questions	8
	1.7	Definition of professional development	9
	1.8	Researcher's background	9
	1.9	Framework for this study	10
Chapter 2	Theoretical framework		12
	2.1	Introduction	12
	2.2	Radical constructivism	12
	2.3	Adult learning and professional development	13
	2.4	Constructivism and research	14
	2.5	Researcher's assumptions	15
Chapter 3	Research methodology		17
	3.1	Type of research	17
	3.2	Reviewing the literature	18
	3.3	Data collection	18
	3.4	Data analysis	22
	3.5	Quality criteria	23
	3.6	Researcher's influence	26
PART B	A REVIEW OF THE LITERATURE		27
Chapter 4	The professional development process		28
	4.1	What is professional development	28
	4.2	Three dimensions for professional development	30
	4.3	Learning implications	33
	4.4	Professional development as a process of change	37
	4.5	Focus for professional development activities	40
	4.6	Summary	43
Chapter 5	Components of the development process		45
	5.1	Introduction	45
	5.2	Components of professional development programmes	45
	5.3	Types of professional development activity	53
	5.4	Five models for professional development	55
	5.5	Summary	57

Chapter 6	Some variables in professional development		59
	6.1	Introduction	59
	6.2	Responsibility and leadership	62
	6.3	Providers	70
	6.4	Location	73
	6.5	Time	75
	6.6	Resources	76
	6.7	Affective influences	78
	6.8	Some economic considerations: costs and effectiveness	80
	6.9	Summary	83
Chapter 7	In-school development		84
	7.1	Introduction	84
	7.2	Establishing a vision	84
	7.3	Planning for in-school professional development	87
	7.4	Needs appraisal	90
	7.5	Role of the head of department	94
	7.6	Regular meetings	95
	7.7	Culture of the school	96
	7.8	Assessment and evaluation	97
	7.9	Summary and conclusions	100
PART C	SOME VIEWS ABOUT PROFESSIONAL DEVELOPMENT		102
Chapter 8	Teachers' views		103
	8.1	Research methodology	103
	8.2	Analysis of data	106
	8.3	Professional development requirements	107
	8.4	Preferred types of development activities	113
	8.5	Influencing factors	120
	8.6	Some comments and conclusions	126
Chapter 9	Mathematics educators' views		129
	9.1	Mathematics educators	129
	9.2	Questionnaire	130
	9.3	Analysis of data	130
	9.4	Professional development requirements	131
	9.5	Types of development activities	134
	9.6	Influencing factors	135
	9.7	Conclusions	137
Chapter 10	Views from policy documents		138
	10.1	Policy documents	138
	10.2	Analysis of data	140
	10.3	Professional development	142
	10.4	Professional development requirements	144
	10.5	Types of development activities	153
	10.6	Influencing factors	155
	10.7	Conclusions	159

Chapter 11	A synthesis of views		160
	11.1	Introduction	160
	11.2	Professional development requirements	160
	11.3	Types of development activities	162
	11.4	Influencing factors	164
	11.5	Some comments	165
	11.6	Some conclusions	166
PART D	SCHOOL-BASED DEVELOPMENT		168
Chapter 12	Organization of school-based development		169
	12.1	Methodology	169
	12.2	Approaches used in schools	171
	12.3	Planning	174
	12.4	Appraisal schemes	176
	12.5	Department meetings	177
	12.6	Summary	179
Chapter 13	Leadership for in-school development		180
	13.1	Introduction	180
	13.2	Professional development for heads of department	180
	13.3	What makes the difference?	181
	13.4	Climate	183
	13.5	Conclusions	184
Chapter 14	Teachers guides		186
	14.1	Introduction	186
	14.2	Production of a guide on professional development	188
	14.3	Methodology	189
	14.4	Reactions to teacher guides	190
	14.5	Responses to the professional development guide	191
	14.6	Conclusions	194
PART E	CONCLUSIONS		196
Chapter 15	Reflecting on the research and the literature		197
	15.1	Research questions	197
	15.2	Overview of professional development	197
	15.3	Organization of professional development	199
	15.4	Leadership in professional development	207
	15.5	Related administrative decisions	210
	15.6	Summary	212
Chapter 16	Recommendations and further research		214
	16.1	Introduction	214
	16.2	General recommendations	214
	16.3	National policy	215
	16.4	National, regional and local networks	216
	16.5	Pre-service education	216
	16.6	Schools	216
	16.7	Individual teachers	218
	16.8	Further research	218

APPENDICES 220

Appendix A Teacher interview schedules 221

A.1 Introduction 221
A.2 Principal 221
A.3 Head of department 222
A.2 Professional development coordinator 222
A.4 Discussion sheet: professional development 222
A.5 Mathematics teachers 224
A.6 Possible follow-up topics 225

Appendix B Questionnaire for mathematics educators 226

Appendix C Policy documents 229

Appendix D Head of department interview topics 234

D.1 Pre-teachers guide 234
D.2 Post-teachers guide 235

Appendix E Draft teachers guide 237

E.1 Introduction 238
E.2 Aims 239
E.3 Responsibility for professional development 240
E.4 Rationale for development 241
E.5 Planning for development 243
E.6 Pre-planning stage 244
E.7 What's available? 245
E.8 Influences on development 246
E.9 Models for development 249
E.10 Costs of development 252
E.11 Effective models 253
E.12 Needs appraisal 254
E.13 Planning stage 256
E.14 Implementation and application 257
E.15 Getting started 258
E.16 Presentation and modelling 259
E.17 Practice and trialing 259
E.18 Feedback and reflection 260
E.19 Support and assistance 262
E.20 Evaluation stage 263
E.21 Looking ahead 264
E.22 Further reading 265
E.23 Other references 265
E.24 Response sheet 1 266
E.25 Response sheet 2 267

BIBLIOGRAPHY 268

LIST OF TABLES

1a	Changes in mathematics in NZ schools since 1950	page 3
1b	Recent mathematics syllabuses and teachers guides	4
1c	Student-centred and subject-centred learning theories	5
1d	Societal trends and their impact on schools	7
3a	Overview of research design	19
4a	Two paradigms for professional development	29
4b	Three dimensions of change	31
5a	Training components and levels of impact	46
5b	Some aspects and actions in the professional development process	47
5c	Types of professional development activity	53
6a	Transition in leadership style	65
6b	Typical roles for effective group functioning	69
6c	Possible in-service providers from outside the school	71
7a	Some purposes, methods, foci and dangers with staff appraisal	91
8a	Details of the six schools from which the teachers were interviewed	103
8b	Status and interview numbers of the 46 interviewed teachers	104
8c	Pre-service training of mathematics teachers	105
8d	Categories of teacher responses	106
9a	Sample of mathematics educators	129
9b	Headings used as a framework for analysis of questionnaire responses	130
10a	Types of policy documents	138
10b	Categories of data from the policy documents	141
11a	Professional development requirements	161
11b	Types of development activities	163
11c	Influencing factors	164
12a	Schools for heads of department interviews	169
14a	Mathematics publications issued to high schools (1983-92)	186
14b	Aspects of the guide seen as useful	191
14c	Aspects of the guide that were new	192
14d	Aspects of the guide seen as needing more detail	192
14e	Consequential changes being considered because of the guide	193

LIST OF FIGURES

3a	Intersecting perspectives on professional development	18
4a	A grid for positioning the focus of professional development activities	40
6a	Possible organizers of professional development	62
6b	Practitioners populations surrounding an in-school change project	68
13a	Location of HODs on a proactive/reactive continuum	182

PART A INTRODUCTION

Chapter 1	An overview	2
Chapter 2	Theoretical foundation	12
Chapter 3	Research methodology	17

This thesis explores the professional development of high school mathematics teachers. It has five parts—an introduction, a review of the literature, one that identifies some views about professional development, another that investigates school based development, and a conclusion.

The first part, this introduction, is divided into three chapters:

1 an overview of the whole study
2 some details of the foundation on which it is based, in particular the ideas of constructivist views of learning that underpin the work, and
3 details of the research methods used.

In the first chapter the research questions (1.6) which are critical to the study are outlined and put into the context which led to the research being undertaken.

In the second chapter the constructivist perspective on learning is outlined. These ideas are assumed to be the basis for learning and since professional development is a form of adult learning, the constructivist perspective is assumed to underpin the development process.

The third chapter outlines the research methods used. These are mainly qualitative methods , these being consistent with constructivism and associated relativist ideas.

Throughout the introduction a portrait of the researcher is built up by reference to his

background (1.8, p.9),
assumptions (2.5, p.15), and
influence (3.6, p.26).

This is important because the qualitative constructions made from the data can then be seen by the reader in terms of the perspective the author brought to the research.

CHAPTER 1 AN OVERVIEW

1.0 Contents

1.1	Introduction	2
1.2	Changes in mathematics education	3
1.3	Changes in educational administration	5
1.4	Changes in society	6
1.5	Some consequences of these changes	8
1.6	Research questions	8
1.7	Definition of professional development	9
1.8	Researcher's background	9
1.9	Framework for this study	10

1.1 Introduction

In recent years policy makers and school administrators have expected teachers to change seem to believe that change can be implemented by legislation followed by the provision of some assistance in the form of resources and professional development. At school level, administrators often hold meetings about their proposed school developments and many assume that teachers will then agree with them and will quickly implement the changes.

Teachers have also sought changes arising from their own needs, concerns and interests. However, they have often felt frustrated in their attempt to bring about change in their classrooms and schools.

During the period of this study, 1989–1994, many expectations for change were impinging on teachers and schools. With the restructured educational administration, professional development delivery systems were also changing. The researcher's concerns were that professional development in the past had not brought about all the intended change, and that new approaches to development which were more effective and efficient needed to be researched.

The aims of this study were to consider the professional development needs of high school mathematics teachers and how these might best be met, and to identify some principles regarding professional development to help planning for development at national, local and school levels.

The changes influencing or intended to influence teachers during the period of this study came from three inter-related sources:

i from within mathematics education,

ii from the restructured educational administration, and

iii from society.

These are considered in more detail in the next three sections.

1.2 Changes in mathematics education

Mathematics education in New Zealand is undergoing considerable change and the rate seems to be increasing. Changes in the content of school mathematics have been made to reflect some of the changes in the perceived importance of some aspects of mathematics and changing practice by mathematicians. A pressure for change in the teaching of mathematics comes from research on learning and from a growing acceptance of a constructivist perspective on learning. Changes in assessment procedures result from a growing concern for better learning, ideas of accountability, and the demands of the new qualifications authority. The changes in the content since 1950 are summarized in table 1a.

Table 1a Changes in mathematics in New Zealand schools since 1950

50s	- calculus was introduced
60s	- *new maths*, with an emphasis on sets, structure and logic was introduced
	- transformation geometry was also introduced
70s	- new courses were developed for F5 (to cater for the growing age cohort staying at school)
	- statistics was introduced into applied mathematics
80s	- the use of computers (and numerical analysis) began to influence applied and then pure mathematics
	- calculators were introduced
	- statistics was emphasized in mainstream courses
	- mechanics was dropped from mathematics
	- problem solving was emphasized
	- bilingual mathematics programmes were developed
early 90s	- needs of less academic students returning to F6&7 were acknowledged
	- increased emphasis was given to calculators and computers
	- increased emphasis was put on mathematical processes as distinct from mathematical content

The evidence for change since 1983 has been the production of five syllabuses, changes in prescriptions and assessment procedures for senior courses, and the production of eight associated teachers guides (see table 1b).

Table 1b Recent mathematics syllabuses and teachers guides

Syllabuses	
1985	Mathematics: Junior Classes to Standard Four
1987	Mathematics: Forms 1 to 4
1989	Draft Syllabus Mathematics: Forms 5 to 7
1992	Mathematics in the National Curriculum (Draft)
1992	Mathematics in the New Zealand Curriculum.
Teachers guides	
1983	School Certificate Mathematics (Form 5)
1985	University Entrance Mathematics (Form 6)
1986	Introduction (Mathematics, Forms 1 to 4)
1986	Ideas (Mathematics, Forms 3 and 4)
1986	Mathematics with Statistics (Form 7)
1986	Mathematics with Calculus (Form 7)
1988	Assessment Ideas in Mathematics (Forms 3 to 7)
1988	Mathematics with Statistics: Supplement (Form 7)

Content changes are inevitable because mathematics is a growing subject. New topics are always likely to be introduced and changes in emphasis will occur from time to time. Examples of areas which may be included in the future are operations research, fractals and chaos theory.

Alongside this curriculum and resource development there has been considerable professional development activity in the form of teacher refresher courses, residential in-service courses and local courses but this activity typically focused on content rather than teaching methods.

How mathematics is taught is closely related to how teachers believe children learn. Ideas about teaching and learning may be grouped broadly as student-centred or subject-centred. These groupings (Begg, 1993) are summarized in table 1c . Constructivism is the most recent of the theories to have influenced mathematics education. It is described in

the next chapter (2.2, p.12). While the writers of the New Zealand curriculum (Ministry of Education, 1992b) did not specify a preferred theory of learning, they were influenced by constructivism. Some evidence of this can be seen from phrases such as meaningful contexts, problem-solving, individual needs, students' ideas and understandings, projects, investigations and explorations. Because constructivism is relatively new for mathematics teachers it is probable that the majority of high school mathematics teachers are not familiar with the theory or its implications.

Table 1c Student-centred and subject-centred learning theories.

Student-centred	Subject-centred
	1900+ Traditional classroom practice
1920 Dewey (Progressive education, projects)	1930s Associationism (drill and practice)
1940s Beeby (playway)	1950s Behaviourism (and behavioural objectives)
1955 Polya (problem solving)	1960s New Mathematics (curriculum reform)
1960s Experiential, Holistic and Alternative Education	1970s Mastery learning (individualized programmes)
1988+ Ethnomathematics	
1990s Constructivism	

Although it may be argued that changes in mathematics education require more research, and curriculum and resource development, this project has been initiated on the alternative assumption that teacher development is crucial and needs careful investigation. Maori people have a saying that encapsulates this idea:
He aha te mea nui i te Ao, He tangata, He tangata, He tangata hi.
(Of all things in the world, the most important is people, people, people.)

1.3 Changes in educational administration

In addition to changes in mathematics education there have been changes in educational administration (Peters, Marshall and Massey, 1994). In particular the Picot Review (Department of Education, 1988c) has influenced high schools and the way that in-service education has been made available since 1989.

Prior to 1989 professional development for high school mathematics teachers was generally organized by the Department of Education's curriculum division, inspectorate and seconded advisers. Other support services included the Teachers' Refresher Course Committee that organized week long vacation courses, and local in-service committees set up by the department which organized one-day courses. Although there was considerable dissatisfaction with one-day courses schools were given an opportunity to influence their focus, and they were generally accepted as providing equitable coverage and as being relatively inexpensive.

After 1989 schools were given more autonomy in terms of some aspects of administration including finance. Through their charters they were made responsible for the professional development of their staff. Various systems for staff appraisal have been introduced or considered by schools to help match development to needs. Although this suggested that schools were taking responsibility for development , when the introduction of the new mathematics curriculum, the Ministry provided mathematics advisers and contracted consultants for development work. There was a financial advantage for schools if they participated in these externally provided activities rather than undertaking the task themselves.

During this same period there has been an increase in the percentage of the student age cohort studying mathematics at senior levels with a resulting need to develop flexible senior courses to cater for them. Further, the New Zealand Qualification Authority has emphasized alternative forms of assessment which were unfamiliar to teachers. These changes have created a need for development activity outside that provided by the Ministry.

1.4 Changes in society

Changes in mathematics education and changes in the administration of education are part of the broader changes occurring in society. A number of these changes have been identified as long-term trends (Naisbitt, 1982). Eight of them have been argued by the author (Begg, 1990) to be affecting schools in general. These trends, and some evidence of their impact on schools, are summarized in table 1d (p.7).

The changes in learning theory (with the emphasis on constructivism rather than behaviourism), research (with the acceptance of qualitative work), educational administration (with the devolution of control) and some of the more general societal changes (1, 2, 4, 7 and 8 from table 1d) fit within a changing era that is sometimes labelled postmodern.

Table 1d Societal trends and their impact on schools.

	Trends	Evidence
1	information explosion,	computers in schools,
2	a world-view rather than national views,	dialogue and cooperation between countries on curriculum and assessment matters,
3	longer term planning,	acceptance of change as a long-term process,
4	decentralization of control,	increased autonomy of schools,
5	self-help rather than institutional help,	self-governing schools
6	participatory rather than representational democracy,	single school boards of trustees
7	networking,	growth of subject associations,
8	multiple options.	increased number of courses in the senior school.

Two further aspects of postmodernism are relevant to this study. One is the concern to find ways to empower people who have not been in the traditional power elite. This means that efforts are needed to ensure that teachers who are other than white and male are no longer marginalized. This aspect of postmodernism is one facet of what is referred to as the 'rejection of the grand narrative' in favour of a plurality of voices and perspectives (Cooke, 1990; Giroux, 1990). The other, also an implication of the 'rejection of the grand narrative' is the likelihood that it will not be possible to develop a single model for professional development that covers all situations because of the complexity and differences within a postmodern society.

A further shift in the context of schools and society is related to schools considering corporate management models. Total quality management (TQM) is one such model which needs to be considered because of the

emphasis it places on professional development. The originator of TQM was the Deming. Initially his work was not accepted in the USA but in 1950 he travelled to Japan, introduced the concept there, and had a considerable influence on Japanese management. Since 1980 his ideas have started to influence western industry and in 1989 he worked with American educators (National Educational Service Foundation, 1993). His management philosophy is a transformative one that relates to administration and leadership. He suggests that any system needs to be considered as a whole rather than as isolated parts. His concept of *quality circles* (Deming, 1986), which is relevant to professional development, involves organizing groups of people who are concerned with bringing about improvement through critical reflection in a formal but non-threatening setting (Holt, 1993).

1.5 Some consequences of these changes

The changes in mathematics education, in administration and in society give rise to many issues for policy makers, teacher educators, school administrators and teachers regarding the professional growth of mathematics teachers. These include the issues of:

i what is professional development,

ii what teachers perceive their development needs to be in the face of the pressures to change,

iii how assistance can best be provided for development,

iv what are the best modes of delivery
- national, local, or school-based,
- block courses or ongoing programmes,

v whether teachers guides are useful in development, and

vi how schools and the Ministry might best use their professional development budgets.

1.6 Research questions

These issues led to the formulation of the following research questions which assumed a need for professional development, but accepted that the content and form of such development activities was problematic.

1 What are the professional development needs of high school mathematics teachers?

2 How might these needs best be met?

These questions led to three further questions:

3 What model(s) for development would be appropriate?

4 What factors influence school-based professional development?

5 Can a teachers guide, incorporating the findings from question 2, help schools with the professional development of mathematics teachers?

1.7 Definition of professional development

The term professional development is one of many that could have been used in this study. It is preferred over staff development, staff education, teacher development, teacher education, teacher change, school development and in-service education since it encompasses teacher learning that results in the teachers changing some aspect(s) of their work in schools to improve (mathematics) learning. The term is seen to encompass other forms of development that have a positive influence on learning and schools by improving teaching or by contributing to the personal growth of the teacher (Taylor, 1980, p.336). It is used here to describe the healthy growth state sustained by a professional which leads to change in practices and beliefs that improve mathematics education. This usage goes beyond the narrower view of professional development as either a way of making up for deficits in the system, or for implementing legislated change.

1.8 Researcher's background

The research in this study is largely qualitative. One implication of this is that the researcher is the instrument (Ball, 1990). Qualitative research cannot be made researcher-proof because the effect, the biases and selections of the researcher cannot be entirely removed. Ball suggests that we would not expect to read a quantitative research report without some idea of the instruments employed to collect data and, in the same way, we should not expect to read qualitative research without some idea of the instrument employed—the researcher herself or himself. It is therefore appropriate to give details about the researcher. His background is outlined in the next paragraph, the assumptions he brought to the research are in section 2.5 (p.15), and some possible influences he had on the research are detailed in 3.6 (p.26).

Background

Before embarking on this research the researcher had had a number of roles in secondary education, namely:

national curriculum officer for high school mathematics,
director of an alternative school,
head of mathematics department,
teacher, and
co-author of mathematics textbooks.

He was well known to mathematics teachers and had been involved in many aspects of their work. During the project he taught graduate courses in mathematics education, was involved in contract work for the Ministry, and was aware of national and international developments in mathematics education. With this background he had the expertise to interpret data in a broad way but there was the possibility that the interpretations might not reflect the teachers' views. This possibility was reduced by asking probe questions to elicit the interpretations of respondents rather than relying solely on the researcher's interpretations.

1.9 Framework for this study

The research is reported in five parts:

A Planning;
B Reviewing the literature;
C Identifying perceived needs and preferred modes of delivery;
D Investigating school-based development;
E Concluding stage.

Part A: Planning

In the first part the theoretical foundations are introduced (chapter 2) and the research design and methodology outlined(chapter 3).

Part B: Reviewing the literature

Chapters 4 to 7 contain a review of the literature on professional development. The review concentrates on aspects perceived as relevant to mathematics teachers in New Zealand high schools. The focus of chapter 4 is the development process and learning; that of chapter 5 is the components of programmes and model(s) for development; that of chapter 6 is specific influences on professional development; while chapter 7 considers in-school development.

Part C: Identifying needs and modes of delivery

Perceived professional development needs and preferred modes of delivery are reported in chapters 8 to 10. Chapter 8 focuses on the views of mathematics teachers, heads of mathematics departments, principals and curriculum coordinators in six schools. Chapter 9 reports the views of a sample of mathematics educators, that is, inspectors, college of education lecturers and mathematics advisers. Chapter 10 is an analysis of mathematics education policy documents (listed in Appendix C, p.229). A synthesis of these three chapters is provided in chapter 11

Part D: Investigating school-based development

Chapters 12 to 14 report on school-based research that addresses the fourth and fifth research questions (1.6, p.9). The focus in chapter 12 is on the organization of in-school development activities and some influences on this. Chapter 13 investigates the roles that key school personnel, including heads of mathematics department, might play in professional development activities. Chapter 14 describes the preparation of a teachers guide and teachers' responses to this guide.

Part E: Conclusion

Conclusions about the research are set out in chapter 15. This includes a reconsideration of the literature in the light of the research findings. Finally chapter 16 contains recommendations for both school and national policy, and suggestions for possible future research.

CHAPTER 2 THEORETICAL FOUNDATION

2.0 Contents

2.1 Introduction 12
2.2 Radical constructivism 12
2.3 Adult learning and professional development 13
2.4 Constructivism and research 14
2.5 Researcher's assumptions 15

2.1 Introduction

This chapter outlines some initial assumptions on which the study was based. These relate to the ideas of radical constructivism and their links with learning, professional development, and research itself. It concludes with a discussion of the assumptions held by the researcher. It provides both the starting point and the direction for the research that follows.

This research was based on the assumptions that

i radical constructivism provides a useful explanation of how learners come to know (i.e. learn),

ii professional development is a form of adult learning, and

iii professional development can therefore be based on constructivist ideas.

Additionally, if constructivist ideas are to influence mathematics teaching, then teachers need to be aware of the ideas of the theory and experience them as learners. Their use within development activities is one way of teachers gaining this experience.

2.2 Radical constructivism

Radical constructivism is a perspective on learning that is gaining international acceptance with mathematics educators. One proponent who has influenced mathematics educators is von Glasersfeld. His views, which inform the present research, are summarized by two principles (von Glasersfeld, 1990, pp.22–23):

1 Knowledge is not passively received either through the senses or by way of communication. Knowledge is actively built up by the cognizing subject.

2a The function of cognition is adaptive, in the biological sense of the term, tending towards fit or viability;

2b Cognition serves the subject's organization of the experiential world, not the discovery of an objective ontological reality.

Constructivism has been interpreted in many ways—which is consistent with the perspective. Most forms value prior knowledge, personal construction, and social interaction in the learning process. Regardless of the interpretation, constructivism is a perspective on learning, not teaching. As Noddings (1990) makes clear, the principles of constructivism do not dictate specific teaching methods. There is still a need to consider the implications of constructivism when considering learning activities.

According to von Glasersfeld (1989, p.163), the radical constructivist perspective has noteworthy consequences for teachers, these include:

i a need to separate teaching for understanding and training for repetitive behaviours,
ii teachers should focus on what can be inferred to be going on inside the learner's head rather than on overt responses,
iii language should be viewed as a tool to aid the learner's construction, not as a means for transferring knowledge, and
iv teachers should realize that learners are trying to make sense of their experiential world and that their errors and deviations from the expected path shed light on how they are organizing their ideas.

Responsibility for all learning (learning of mathematics and teachers' learning) rests with the learner. This is because learning is an active process. If the learner does not engage, does not try to make sense of experiences, then learning will not occur.

While learning can occur without teaching, a teacher can facilitate the construction of knowledge. To do this successfully a teacher needs to take account of prior experiences and interact with learners to find out what they are thinking and to provide challenges to their thinking.

2.3 Adult learning and professional development

From a constructivist perspective two factors that influence learning are context and prior experience. These vary for different learners. Adults involved in professional development activities are older than students in schools and this means there are differences in terms of context and experience. These are:

i Adult learning is virtually always voluntary and, related to that, adults' motivation to learn is usually high.

ii Adults have a rich background and considerable prior experience to draw upon. Thus when they make sense of new experiences they usually have a robust framework of ideas to link to. This may mean that they are reluctant to change their ideas because their prior constructions have stood the test of time and any new perturbations are not necessarily seen as important enough to cause a rejection of previously held ideas.

The professional development of a teacher needs to be seen as the responsibility of the teacher rather than the provider since:

- learning is the responsibility of the learner rather than the teacher,
- adult learning is voluntary, and
- learning often occurs without teaching.

2.4 Constructivism and research

Constructivist ideas have a number of implications for research (Lincoln and Guba, 1985). The first implication has to do with external reality. Whether an absolute reality exists is not seen to be important. If it exists then radical constructivists assume that they have no direct access to it; all they can do is make sense of their experiences in terms of what they already know by constructing a viable model of it. As each person has different prior experiences the models constructed will vary.

The second implication is that while making sense of experiences involves personal construction, learning also involves social interaction. For the researcher data can only be interpretations of reconstructed thoughts of individuals. These are likely to vary between subjects and between a subject and the researcher because of different prior experiences and the resulting differently constructed prior knowledge. Related to this is the fact that the knower and the known are not independent; coming-to-know is often an interactive process.

The third implication has to do with cause and effect. In general the constructivist sees situations not as simplistically linked in terms of cause and effect, but as mutually interacting influences that shape both the knower and the known. Thus studying single and often independent variables is not appropriate. One needs to look at data in a holistic way and to accept the values which link with them.

The fourth implication has to do with generalizability which is a traditional concern of research when theories that are developed are considered to be applicable across time and in a number of contexts. The constructivist does not hold such an expectation. Instead, all that is considered possible is a working hypothesis that describes a situation. This may of course, have some similarities with other situations and indeed illuminate them.

Throughout this project the researcher assumed that the traditional objectivity of quantitative/empirical research has been replaced by an acceptance of inter-subjectivity. To emphasize this Ball (1990) suggests the use of "I" in the writing of research. He says that this would reflect the 'researcher-as-instrument' which would be preferable to writing the researcher out of the report and denying the dependency of the data on the researcher's presence. Against this, the conservative traditions of research suggest retaining a more neutral stance and somewhat reluctantly I allowed this conservatism to influence me.

2.5 Researcher's assumptions

Because of the interaction between the knower and the known, it is important to be aware of where the researcher is coming from. The researcher brought a number of assumptions to this project. These included the following:

i Approaches to learning, teaching and research that fit with constructivism are more useful than transmission and psychometric approaches.

ii Professional development is an ongoing two part process consisting of pre-service and in-service (including induction). This project focuses entirely on the in-service part.

iii Involvement in curriculum and resource development, research and school development are all forms of professional development.

iv Presenting teachers with something such as a syllabus or resource, does not usually alter their behaviour in the classroom.

v Effective professional development needs inputs from theory and research, together with experience in applying these inputs.

vi Empowerment is preferable to dependency and this should be reflected in professional development activities.

vii Individuals have different needs.

viii Professional development is a right and a responsibility of every teacher in the same way that it is for people in other professions.

Efforts were made to test these assumptions during the study, by looking carefully during visits with heads of department for contrary evidence.

At the start of the project professional development was viewed as an independent variable that would influence the improvement of student learning, although other aspects of development (development of learning theories, of curriculum and resources and of assessment procedures) were linked. This viewpoint was revised as a consequence of reviewing the literature and talking to teachers. Many other aspects of school were seen to be connected. These included styles of management, the philosophy and culture of the school, the locality of the school, and the staff turnover rates. Although professional development was still considered very important, it had to be recognized that it was only one factor in a rather more complex picture.

The study was started with an underlying assumption of cause and effect and a desire to formulate a general model for professional development that would be an improvement on traditional practice. As the research progressed these were replaced by a realization that:

- the relationship between aspects of development are better represented by a dynamic interaction rather than a linear programme;
- while traditional methods have not been successful with all people, they had influenced many;
- a general solution within the context of typical New Zealand high schools may not exist.

At a pragmatic level the researcher was aware that only limited funds are available for educational development and assumed that it was desirable to investigate low cost professional development alternatives and to ensure that the benefit from these funds is maximized.

CHAPTER 3 RESEARCH METHODOLOGY

3.0 Contents

3.1	Type of research	17
3.2	Reviewing the literature	18
3.3	Data collection	18
3.4	Data analysis	22
3.5	Quality criteria	23
3.6	Researcher's influence	26

3.1 Type of research

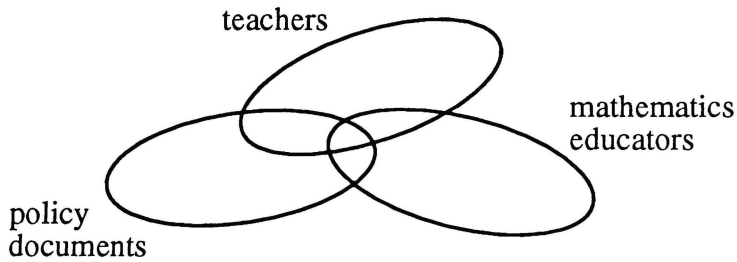
The original two research questions and the other three that emerged—What are the professional development needs of high school mathematics teachers? How might these needs best be met? What model(s) for development would be appropriate? What influences affect school-based professional development? Can a teachers guide, incorporating the findings from the second question help schools with the professional development of mathematics teachers?—were researched using a qualitative approach in which the researcher interacted with a range of views about professional development.

The research was grounded-research with my conclusions emerging from the experiential knowledge of the people involved (Merriam and Simpson, 1989; Guba and Lincoln, 1981). It was quasi-ethnographic rather than ethnographic because the researcher's prior understanding was of the culture of high schools in general but not of each particular school. The research was also naturalistic because the researcher and the subjects interacted, the interactions were value laden, and they differed with the different participants in the research (Borg and Gall, 1989).

The original intention had been to consider six schools as case studies, and to compare and contrast them, but the commonality between them and the realization that the differences were caused by individuals rather than schools, resulted in that approach being abandoned. The data were viewed holistically, since a perspective related to national and school policy formulation was preferred to one related to individuals. The data were collected using interviews and questionnaires, from a content analysis of reports, and from response sheets and interviews after an intervention by the researcher that involved a teachers guide on professional development (appendix E, pp.237–268) being distributed.

Ethnographic research can be thought of in terms of organizations, cultures and perspectives (Wiersma, 1986). In this study the organization was the high school mathematics education community, the culture was that of professional development, and the perspectives were the three overlapping groups that impinge on the organization of school mathematics—teachers, mathematics educators, and policy document directives (figure 3a). The findings from these three groups are reported separately in chapters 8 to 10 and brought together in chapter 11.

Figure 3a Intersecting perspectives on professional development



3.2 Reviewing the literature

A major part of this research was an extensive review of the literature on professional development with an emphasis on aspects relevant to mathematics and high school teachers. Most research on professional development has been done overseas and much has been done with teachers other than mathematics teachers. Reviewing this literature helped put the New Zealand position into an international perspective where a broader range of practices occur. The literature review is reported in Part B (chapters 4, 5, and 6) and is subdivided under three headings: the professional development process, influences on professional development, and in-school development.

A form of literature review, a content analysis of policy documents, was an important component of the research. This involved searching for policy directives related to professional development and is reported in chapter 9.

3.3 Data collection

Data were collected on the views on professional development of teachers (principals, curriculum coordinators, heads of department and assistant teachers), mathematics educators, and from policy

documents. This required survey research of an ethnographic nature that involved collecting data rather than manipulating variables. The research was based on a constructivist perspective; the researcher tried to find what others constructed as their meaning. While any prior ideas of the researcher may have influenced the direction of probing, as far as possible the questions were open-ended to enable the collaborating participants to communicate their ideas. The methods of data collection in the three parts of the research are summarized in table 3a and more details about the samples are in chapters 7, 8, 9, 11 and 13.

Table 3a Overview of research design

Dates	Description of phase	Data collected	Methods of data collection	Sample
Aug 89 to May 90	Stage 1 Planning			
Aug 89 to May 94	Stage 2 Literature review	ideas about professional development process, influences, & in-school development	critical analysis	
Aug to Dec 89 Feb to Aug 90 Feb 90 to May 91	Stage 3 Identifying needs and modes of delivery	views on perceived professional development needs and preferred modes of delivery	questionnaire semi-structured interviews with open-ended questions content review and analysis of reports etc.	15 mathematics educators 30 teachers 6 h.o.d.s 6 principals 4 curriculum coordinators 53 policy documents
Sep 92 to May 93	Stage 4 Investigating school-based development	views on in-school development (in practice and planned) and reactions to teachers guides	semi-structured interviews response sheets	14 heads department 24 teachers and others
May 93 to May 94	Stage 5 Conclusion			

Interviews

Interviews are conversations initiated to obtain information and in this study semi-structured interviews were used. Bell, Osborne and Tasker (1985) have written about interviewing children. Their guidelines are relevant with adults and guided the researcher. In summary they are:

- the aim of the interview is to get the interviewee to talk
- the skill of an interviewer is to know when to ask a question and what question to ask
- build confidence with non-threatening questions at the start
- use a balance of open and closed questions
- the interviewer should remain neutral
- allow adequate wait time
- explore doubts and hesitations
- use probe questions to follow up but do not lead
- be sensitive to contradictory responses
- maintain a non-threatening and confidential stance.

In the semi-structured interviews the researcher had a list of issues to explore through open-ended questions. Neither the wording nor the ordering of questions was fixed (Merriam 1988). The researcher pursued ideas as they arose, probed deeper when appropriate, moved quickly when no information emerged, and avoided questions where answers had been given as part of an earlier extended response.

Teacher interviews

The interview schedule for the teachers was discussed with colleagues and modified in the light of their comments. It was piloted with the first two interviews and minor changes were made for the other interviews. The interviews with the heads of department, the principals and the curriculum coordinators in this phase used modifications of this schedule (see appendices A1 to A7, pp.221–225).

The interviews were audio-taped and transcribed. The transcripts were sent to the interviewees with the understanding that additions or alterations would be welcome if they added to the meaning, represented things that the interviewee had forgotten to say, or reflected the intended meaning. Only a small number of changes were requested and these were made. Interview data were treated as anonymous and confidential in that information was not shared between participants except through the written research reports.

The success of interviews depends primarily on the quality of the interactions between the interviewees and the interviewer. Without exception the respondents gave gladly of their time, answered all questions in detail, and in many instances shared details of their professional and personal life that were confidential. A number said that being able to discuss their professional career was an unusual experience. In this environment the quality of their responses seemed very satisfactory to the researcher. The results of these interviews are reported in chapter 7.

Heads of department interviews

The six heads of department were identified in the initial interviews as being the richest source of data amongst the teachers and the information they shared often included much of what the other teachers said. As a result the decision was made to interview more heads of department in part D of the project and not the assistant teachers. The original six and a further eight heads of department were interviewed twice during the fourth stage, firstly in late 1992 before they were given the teachers guide to distribute, and secondly in term 1 of 1993. The schedules of open-ended questions for these semi-structured interviews are in appendices D1 and D2 (pp.234–236). The participants were encouraged to talk about a number of related issues and the interviewer ensured that virtually all the questions were covered. The schedule was modified with some heads of department to obtain feedback on their different experiences. Data from these interviews are reported in chapters 11, 12 and 13.

Questionnaire - mathematics educators

The questionnaire for the mathematics educators (appendix B, p.226) centred on concerns and priorities for development rather than on the methods of delivery and the influences of various factors. The response rate, (15 from 31 requests) might be regarded as reasonably high for a postal questionnaire but was not as high as the researcher had expected from these close colleagues. Sending a reminder was considered but most of these educators were caught up in the restructuring of educational administration and this was a stressful time for them. Those who did not respond were identified and as 10 of the 16 were primary mathematics advisers who spent only a small part of their time in high schools it was thought that the responses received represented a good cross-section of the population. Their views are reported in chapter 8.

Document analysis

The analysis of the content of policy documents (syllabuses, teacher guides, education reports, non-government reports and guide, and overseas reports, listed in appendix C, p.229) focused on professional development matters to do with mathematics teachers in their role as teachers and in their more general role as staff members. All mention of professional development needs and suggestions about modes of delivery were noted. These are reported in chapter 9.

Questionnaire - teachers guide

Just over one hundred copies of a teachers guide on professional development written by the researcher were distributed in term 3 1992 by the heads of mathematics to their staff. There were two response sheets in each guide, one to be completed when the teacher had skim-read the booklet and the other after they had had time to reflect on the contents. The teachers guide and the two response sheets are in appendices E1–23, E24 and E25 (pp.237–267).

The teachers were invited (not pressured) by their heads of department to hand in responses and 22 response sheets #1 and 2 of #2 were returned. The number of responses was not as high as had been hoped, (12%), but this reflected the pressure from change that many teachers were under at the time. The guide had been discussed in schools and more feedback from teachers as well as the interviewees was obtained through the interviews with heads of department. This meant that responses were from the keener teachers and the more active departments but the feedback received was rather unenthusiastic and probably does reflect the views of many teachers. These findings are reported in chapter 13.

3.4 Data analysis

The data were obtained from open-ended responses from questionnaires, interviews, and response sheets and from the analysis of policy documents. The interviews had been audiotaped and transcribed (and checked by the interviewees) so the data analysis was done by reading written material and categorizing the information. The categories emerged during the analysis and common responses were counted to provide some indication of the extent to which a view was held. A full statistical analysis was not appropriate as the data were qualitative and the different data sources did not all address exactly the same issues.

3.5 Quality criteria

Validity and reliability are the traditional measures of quality of research done in a positivist paradigm (Guba, 1990b; Lincoln, 1990; Smith, 1990; and Marshall, 1990). This research has been within a qualitative paradigm that fits with constructivism (see 2.4, p.14) and these traditional measures of quality do not seem as appropriate. Honesty, openness and precision are three suggested alternatives for qualitative research but should be regarded as axiomatic.

Noddings (1990, pp.14–15) says *in research ... we have to investigate our subjects' perceptions, purposes, premises and ways of working things out if we are to understand their behaviour.* One way to ensure the quality of such research is to check it with the subjects to see whether the interpretation constructed by the researcher fits with their construction. This was done for the parts of the research involving interviews.

Qualitative, ethnographic and naturalistic methodologies require the researcher to elicit individual constructions, refine and interpret these, and compare them to constructions on which there is substantial consensus (Guba, 1990b). In this case the aim was to produce guidelines with which individual constructions fitted.

Alternative ideas about validity

Maxwell (1992) has suggested alternative aspects of validity (and reliability) that might be relevant with qualitative research. These are descriptive validity, interpretive validity, theoretical validity, internal generalizability, external generalizability, and evaluative validity.

The first three of these relate to

i the factual accuracy of a report,

ii how facts are interpreted by the people involved, and

iii how conclusions might validly represent the ideas reported.

Difficulties arise with these because with different prior experiences and existing knowledge things may be seen and interpreted differently by different participants. When interviewing it was possible to ask for examples and clarification to ensure common understandings, but this was not possible with written responses. The general lack of contrast in the data meant that the interpretations made by the researcher do fit the data and thus the descriptive and interpretive aspects might be

regarded as being satisfied. The way that interpretations are linked to conclusions remains somewhat problematic.

Internal and external generalizability are to do with whether ideas from the research can be applied within the community being studied (in this case high school mathematics teachers in New Zealand) and beyond this community (to teachers of other subjects, at other levels, or even in other countries). The researcher acknowledges that the results are not necessarily generalizable to these groups because

i mathematics teachers in different regions may display significantly different attitudes to innovation,

ii teachers of other subjects do not all belong to large departments as mathematics teachers usually do,

iii teachers at other levels, in particular primary teachers, are not generally organized into subject departments and have responsibility for many subjects, and

iv teachers in many other countries are likely to have had very different experiences and their expectations would consequently differ.

Although internal and external generalizability might not be possible, the purpose of this research was to identify general principles not provide specific solutions so insights gained from this study are likely to be of some relevance to other groups.

Evaluative validity is not relevant here as the project is concerned with description, interpretation and explanation rather than evaluation.

In this project the researcher's prior experience and familiarity with the ideas being expressed enabled him to use appropriate supplementary questions and to reach conclusions which may have been different from those of researchers working with alternative frameworks. However, Ball (1990) suggests that such differences in analyses by different researchers would be likely to be small and more matters of emphasis. The more important question is whether the conclusions are illuminating for the participants. In this regard a knowledgeable researcher would be expected to synthesize data to reach a conclusion that will enjoy considerable consensus and thus the quality of the research is dependent on the researcher. Kincheloe (1991) reached the same conclusion when he suggested that trustworthiness might be a

better quality descriptor than validity in the non-positivistic context. If this criteria is used then it may not be appropriate for the researcher to be the judge of quality.

Relevance

The purpose of this research was to elicit as many views as possible , to reach some general conclusions based on them, to present some guidelines for teachers to use when constructing a view of professional development possibilities and programmes in the context in which they are working. The relevance rather than rigour criterion (Guba and Lincoln, 1981) seems preferable to the traditional ideas of reliability and validity. The questions regarding quality might be:

- are all the relevant constructions being considered? and
- are none of the frameworks needed for substantial consensus being omitted?

The test for internal or external generalizability would be whether, when presented with the ideas, teachers found them to be relevant.

Within this project an opportunity was provided for mathematics teachers to comment on the relevance of the ideas through considering a teachers guide. Thus there was some consideration given to external generalizability, but the process of finding whether the ideas are useful in the long term was beyond the scope of this project.

Triangulation

The extent to which data gained from a number of sources (triangulated) substantially agrees provides a measure of the quality of the research. In this project the range of people being interviewed and their different experiences meant that the data that was expected to be observed would be rich and supplementary rather than repetitive, and when sources other than teachers were probed, the ideas were expected to be derived from different perspectives. The task of the researcher was to make sense of a rich tapestry that was expected to emerge rather than to emphasize similarities.

Other quality criteria

The ideas of robustness (straightforward, not confused by subtleties) or stability (not overly sensitive to marginal perturbations) are useful when considering the aspects of validity related to generalizability and might be viewed as useful criteria. However, the concept of generalizability is problematic in a postmodern context because it makes assumptions about the likely existence of a grand theory.

3.6 Researcher's influence

In terms of not being able to make the research *researcher proof* (Ball, 1990, p.167) and in terms of the quality of the research it is important to identify any influence that the researcher may have had. To supplement the researcher's background (1.8, p.9) and assumptions (2.5, p.15), possible influences are now considered.

The researcher, because of his background, previous employment, and personality had an influence in this study and it would be incorrect to assume that he was a neutral observer. He was well known as a teacher, text writer, curriculum officer, and resource person in development activities. He had previously developed a good working relationship with many of the participants who were sampled. On a number of occasions his presence as interviewer caused interviewees to reminisce on shared experiences and their stated opinions may have unconsciously reflected what they had shared in the past.

In terms of the New Zealand mathematics policy documents (appendix C, p.229) the researcher had played a major role in the preparation of some of them (in particular D 1 and D 3–9, and D 30). He had organized working parties that produced and edited eleven of them and as a curriculum officer had possibly influenced some of the others.

The researcher's influence is part of the background to the project and the researcher was not trying to ignore this. However, the project was trying to get the views of teachers by asking open-ended questions and by trying deliberately to suspend putting a framework on to the data until it had all been collected. Thus the researcher tried to minimize any bias based on his participation in the research.

From prior experience the researcher believed that curriculum documents, texts, and guides that require a change in behaviour from teachers will be adapted rather than adopted. This project therefore began with the assumption that the methods currently being used for professional development may need considerable modification.

PART B A REVIEW OF THE LITERATURE

Chapter 4	The professional development process	28
Chapter 5	Components of the development process	45
Chapter 6	Specific variables in professional development	59
Chapter 7	In-school development	84

Part A introduced the study. Part B, the literature review, gives the study a wider perspective by providing ideas from outside New Zealand. The literature review began before data collection, and continued during and after it. The focus for the parts of the literature review emerged during the research and was influenced by the data analysis.

The first chapter of the literature review (chapter 4) is concerned with the professional development process and the focus for development activities.

In chapter 5 the focus moves from the process to the format of development programmes. The components are discussed and fitted together and models for professional development are considered.

Chapter 6 looks at more specific variables that influence professional development, particularly variables that are influencing schools in New Zealand in the early 1990s. The analysis points towards a need for in-school development, the implications of which are considered in chapter 7.

Chapter 7, the final chapter of the literature review, considers the factors that need to be thought about when planning for professional development within a school. Some conclusions are then discussed.

Chapter 9 in part C is also a form of literature review. This contains an analysis of mathematics and education policy documents that refer to or imply the need for professional development.

Chapter 4 THE PROFESSIONAL DEVELOPMENT PROCESS

4.0 Contents

4.1 The nature of professional development 28
4.2 Three dimensions for professional development 30
4.3 Learning implications 33
4.4 Professional development as a process of change 37
4.5 Focus for professional development activities 40
4.6 Summary 43

4.1 The nature of professional development

In chapter 1 (1.7, p.9) professional development was defined as 'the healthy growth state sustained by a professional which leads to change in practices and beliefs that improve mathematics education.' It encompasses forms of development that have a positive influence on learning and schools by improving teaching or by contributing to the personal growth of the teacher.

This definition is accepted by many researchers (Fullan and Stiegelbauer, 1991; Skilbeck, 1990; Bolam, 1987; Guskey, 1986) but has been interpreted as limiting by some others (Jaworski, 1991; Oberg and Underwood, 1989; Nias, 1986) who focus on a more personal view of development, emphasizing the need to preserve self-identity, to reflect on personal practice, and to search for the educational ground *where one stands (in the present) as the locus of one's roots (in the past), and as the source of nourishment for growth (into the future),* (Oberg and Underwood, 1989, p.164). Within this range of opinion a gender bias seems to be emerging with women preferring the personal rather than the output orientation (Hargreaves and Fullan, 1992).

The above definitions contrast with the traditional views where professional development is seen as being imposed with the aims being to rectify teacher deficits and to implement legislated change.

Whether professional development is concerned with imposed change or whether it is a learning process is a dilemma that has faced planners and providers of professional development. These contrary approaches have been summarized by Day (1987) who referred to the teacher who is developed (passive) and the teacher who develops (active) and by Robinson (1989) with reference to the management and empowerment paradigms. Table 4a is derived from Robinson's work.

Table 4a Two paradigms for professional development

Aspect of Change	Management Paradigm (Imposed change)	Empowerment Paradigm (Learning)
Focus	change	choice
Source of knowledge	experts/theorists	teachers/practitioners
Starting point	new idea imported from outside	teacher's own strengths and abilities
Locus of power/ control	outside agents: consultants/advisers	teachers
Indicator of success	change in teachers: adoption of (someone else's) new idea	responsible decision making by teachers
Role of teacher	acolyte	decision maker
Expectation of teacher	immediate adoption or revolution	gradual development or evolution.
Role of outsider	change agent	choice agent
View of teacher	obstacle to be overcome (deficient & devious)	competent and responsible professional
Mode of operation of outside agent	propaganda/pressure to change	presentation of choices/support for risk-taking
'Images' of outside agent	'salesperson' 'guru'	'facilitator' 'colleague'
Typical outcome ... leading to	Apparent but current superficial change ... reversion to old behaviours when pressure comes off	Gradual refinement of practices ... decision to adopt new practice on an on going basis

No recent research sighted by the researcher suggested that the management paradigm was appropriate, but some policy documents (chapter 9, p.129) imply that it typifies the view of professional development and implementation held by some administrators. Further, many forms of in-service work such as one-day courses and contracted development facilitators with specific briefs seem underpinned by such a view.

Constructivist learning that starts with the prior experiences and knowledge, and the interests and concerns of learners implies an empowerment model of development. Other researchers supporting a learning focus have taken various viewpoints. Diamond (1991) and Mezirow (1990) supported teachers critically examining their practice;

Clark and Wilson (1991) believe that context is the element that brings meaning to experience; Clarke (1991) suggested making one's work problematic by looking in one's own back yard and making the familiar strange as a way of bringing the work context into the process. Goldenberg and Gallimore (1991) suggested engaging teachers in examining their teaching, the challenges and problems they face, possible solutions, and whether there is progress in addressing these challenges.

On the other hand Elbaz (1987) thought that when teachers focus on their own work, their concern with solving problems tends to interfere with the deeper search for understanding. Mousley and Rice (1989) voiced similar concerns. They felt that the impact of development activities is usually superficial because most mathematics teachers are still largely bound by the traditions of teacher-centred classrooms. In their view, real change involves taking on a new philosophy and confronting the norms of the dominant hegemony.

The emphasis on professional development as a learning process rather than imposed change suggests the need:

i for a fundamental philosophical shift by teachers, and

ii to promote continual professional growth rather than growth based on specific projects (Sadowski, 1993; Rice, 1992).

4.2 Three dimensions for professional development

The word professional in the phrase 'professional development' clearly indicates the professional dimension within development but it is not the only dimension that needs to be considered. Bell's (1993a) analysis of the development process suggests that there are three interrelated dimensions to change—personal, social and professional (Bell and Gilbert, 1993). Researchers such as Sadowski (1993) have also emphasized the interrelationship of these dimensions and claim that the separation of the personal and professional is neither necessary nor desirable. These dimensions have three phases, summarized in table 4b (derived from the work of Bell and Gilbert, 1993, p.370).

Table 4b Three dimensions of change

Dimensions	Stages
personal	attending to feelings - accepting an aspect of one's teaching as problematic - dealing with restraints - feeling empowered
social	developing collaborative ways of relating to others - seeing isolation as problematic - valuing collaborative ways of working - initiating collaborative ways of working
professional	developing ideas and actions - trying out new activities - developing ideas and classroom practice - initiating other development activities

This broadening of development to include the personal and social is supported by Thiessen (1992) who was concerned with classroom-based teacher development, and Hollingsworth (1992) who has changed her approach to development to articulate an emerging feminist consciousness.

Other aspects of the personal dimension of development have been referred to by a number of writers: Daresh (1989) emphasized the highly personalized nature of the professional development experience; Flannery and Wislock (1991) stressed the importance of personal refection, that is, becoming aware of one's personal philosophy by examining what one does and why one does it; Burns (1989) has written about the importance of self-concept in teacher education; and McKibbin and Joyce (1980) found that teachers who felt best about themselves transferred nearly seven times more from the content of training than did those whose self-concepts were most precarious. All these viewpoints reinforce the need to include the personal dimension in a professional development model as Bell and Gilbert (1993) have done.

In a similar way, the need to consider the social dimension is reinforced in the writing of other researchers. Jaworski (1991) suggested that sharing power and working collaboratively was one way of supporting

change; Thiessen (1992) emphasized the need for support in small schools or amongst hostile colleagues; and Robertson (1992) stressed the need for social support in terms of what women often have to endure in sexist environments. The idea of reflection that involves interacting with supportive colleagues is another part of the social dimension, perhaps the most important, since such social interaction is seen as a valuable component in successful learning from a constructivist perspective.

Congruence and autonomy

Two other ideas that relate to the personal dimension of professional development are the ideas of congruence and autonomy. Congruence, a term used by Rogers (1961, 1969), is a matching of 'who a person is' with 'what the person does'. This idea is supported by Perls, Hefferline and Goodman (1951) who argued, in the context of Gestalt therapy, that change occurs when one becomes what one is, not when one tries to become what one is not. It is also consistent with Blackman's (1988, p.2) view that professional development focus on *what the teacher is and can become* rather than on *what the teacher can do,* and with Richardson's (1990, p.13) contention that *the teacher teaches as he or she is.*

Autonomy is considered personal self-rule. Fullan (1993b, p.130), in the phrase *every person is a change agent,* emphasizes the individualistic role of teachers even when they are part of a social group. Teacher autonomy was also emphasized by Hudson (1991) when he wrote of the need to trust one's vision, and to take responsibility for one's life course and to learn how to learn, unlearn and relearn. Although some educators recognize the value of teacher autonomy in the professional development process, this is not necessarily part of the school ethos/climate. Wildman and Niles (1987, p.5) for instance, concluded that teachers, *for the most part, are not encouraged to engage in autonomous, entrepreneurial work. They are encouraged to toe the line, to stick to the dictates of the bureaucracy, and to maintain the status quo.* Their conclusion seems relevant in the New Zealand situation and planning for professional development obviously needs to address this issue of autonomy. This is not likely to be easy as many entrenched views are likely to exist which do not respect the autonomy of teachers.

Congruence and autonomy do not imply that external influences are not relevant—Rogers (1969) spoke of control from inside and impetus or stimulus from outside; the rejection of the change agent by Perls, Hefferline and Goodman (1951) referred to coercion rather than facilitation; and the claim by Blackman (1988) that teachers create their own agendas for development referred mainly to focus. The implications of congruence and autonomy for development are summed up by Robinson (1989, p.280) in two seeming paradoxes:

i *We don't change by trying to change, but by trying to be more fully what we are.*

ii *We are more likely to facilitate change in other people by abandoning altogether the aim of trying to change them, and rather giving them (a) the opportunity to be fully themselves, (b) the vision to become aware of the choices around them, and (c) the support to venture down whatever road they choose.*

These 'paradoxes' suggest that teacher development includes aspects of self-discovery and helping others discover themselves.

4.3 Learning implications

This section explains professional development in terms of learning theory. Constructivism was introduced in chapter 1 (p.4) as underlying the writing of *Mathematics in the New Zealand Curriculum* (Ministry of Education, 1992b) and in chapter 2 (pp.12–14) it was described more fully and related to children's and adults' learning. In accepting constructivism as a basis for learning by teachers (as well as by students) there is a need to focus on the theory in terms of the learning process (table 4c) and consider what influences this process.

The constructivist learning process for teacher development usually begins with the learner wanting to learn. This may stem from a recognition of a problematic aspect of their teaching or some dissatisfaction with it. The learning depends on the teacher's prior experiences and the prior knowledge that resulted from these experiences. The learning requires active consideration of new possibilities, which may involve watching and practicing new skills and ideas, reflecting on these, and accommodating or assimilating them. As the new skills and ideas are introduced into the teacher's professional work, learning continues until they are finally integrated into the teacher's mental schema and practice.

Four aspects of this development process are considered in this section—the establishment of goals for development, influences of prior experiences on learning, the need for active thinking or reflection in learning, and the role of the professional development facilitator. Other aspects of the process are considered when the components of development activities are discussed, (5.2, p.45).

Establishment of goals

The establishment of goals is an aspect of development. Davis, Jones and Pearn (1993) stressed the need in planning to be flexible and to negotiate with the learners; this implies broad rather than specific objectives. Mellin-Olsen (1993) affirmed the importance of goals citing Vygotsky and Leont'ev's goal-directed activity theory. He claimed that all learning is goal directed, learning takes place in the context of a goal, the facilitator needs to establish the goal, and the learner needs to share it. This negotiation of shared or co-constructed goals is particularly important in professional development because adult learning typically involves an awareness of personal learning goals and their application. Further, self-directedness in learning generally increases with maturity. The immediate and individual goals for a teacher might have to do with what is problematic in the teacher's work. For a group of teachers it might have to do with a more general dissatisfaction, and for school development it might involve a reconsideration of how professional development is viewed.

Influence of prior experiences

From a constructivist perspective prior experiences and the resulting knowledge influence learning. The differences between child and adult learning have already been discussed (2.3, p.13) and it has been acknowledged that the prior experiences of adults (teachers) are likely to be very rich and provide a robust framework to link new ideas to. As part of this framework many teachers start with a range of implicit and explicit learning theories developed from their prior experience; in many instances these are behaviourist views. Such views are likely to be deeply embedded by enculturation, including pressure from colleagues (Taylor, 1991). If development is to help teachers move from a behaviourist view, then the task will be difficult especially if the development activities use non-behavioural strategies without explanation. Under such circumstances it is highly probable that some teachers will reject them.

Gardner (1991) acknowledges the influence of prior experiences when he claims that apprenticeship is a successful form of learning. This notion is important when one considers that a new teacher of mathematics has already served a 16 year 'apprenticeship' in classrooms. Raymond, Butt and Townsend (1992) speak of what is learnt in such an apprenticeship as acting as lifelong reference points, and Kennedy (1991) expresses doubt that academic and pre-service education will counteract some aspects of this apprenticeship. In in-service education a similar concern exists and t must be assumed that change will at least take considerable time.

Researchers such as Huberman (1989) have linked age stages with career stages in teaching (beginning teacher through to near retirement). These stages are argued to have an influence on both the professional development needs of the teachers and the prior experiences that they bring to development activities. An alternative perspective is to consider the key personal issues that one works on during one's life. Oja (1983, cited in Oja, 1988) listed fourteen of these, which were independent of the teachers' professional roles, and used them to help characterize the life periods of teachers described in her work. This is similar to the approach of Kelchtermans and Vandenberghe (1994) using critical incidents (critical phases influenced by critical persons) although these may also occur within schools. Using personal/critical phases or career/age stages, one sees teachers at different stages, facing different issues, and bringing different experiences to development. They want different things from development. They think differently about teaching (Carter, Cushing, Sabers, Stein & Berliner, 1988). They project different images towards development (Doyle and Ponder, 1977). They behave and respond differently in the classroom with the younger teachers being more likely to be open-minded and the older ones being more likely to respond more flexibly (Krupp, 1987). While it may not be worthwhile to use a 'stage' approach in planning development, an awareness of the stages provides insights to the complexities of teachers lives and development needs.

Finally there may be a mismatch between the actual prior experiences, knowledge, beliefs and practice that a teacher brings to development activities and the espoused recollections of these. The mismatch results, according to Ernest (1989a, p.27), from three causes:

i *... the depth of the espoused beliefs: the extent to which they are integrated with other knowledge and beliefs, especially pedagogical knowledge. If the beliefs are represented in a disconnected verbal way, without rich connections to other beliefs and knowledge, only a limited basis for their enactment exists. Hence a disparity between espoused or stated beliefs and actions, should not be surprising.*

ii *... the teacher's level of consciousness of his or her own beliefs, and the extent to which the teacher reflects on his or her practice of teaching mathematics, leading towards a greater integration of beliefs and practice.*

iii *...the powerful influence of the social context. This results from the expectations of others, especially teachers and superiors. It also results from the institutionalised curriculum embodied in adopted texts, the system of assessment, and so on. ...*

Reflection

Reflection in teacher development has been defined as the process of stopping for a moment (or longer) to think about what has occurred, and to try to make sense of it in order to learn from experiences: It may involve talking through one's ideas with the thoughtful attention of another person, to clarify confusion, identify questions and reach significant insights (Gilbert, 1993, pp.28–29). Thus reflection can be thought of as part of the active thinking stage in constructivist learning where ideas and experiences are being processed individually or with the support of one or more colleagues.

This concept of reflection is what separates routine action from reflective action and learning experiences from other experiences. The reflective teacher who reflects-in-action (Schön, 1987) is involved in uncovering the tensions between teaching practices, personal theories of learning and teaching, values, and the broader school and societal contexts. Schön suggests that educating teachers to be reflective involves allowing them to learn by doing and providing support via a 'coach' who interacts with them to them assist in the recognition of good practice and images of expertise whilst teaching.

If professional development activities are to be successful then they need to provide both opportunities for reflection and assistance for teachers to become more reflective.

Role of the facilitator

Traditionally much professional development has occurred with considerable input from outsiders or from a resource person. With a move to a constructivist perspective the role of such a facilitator of development needs to be reconsidered. Similarities exist with a constructivist classroom where the teacher's role is one of facilitating learning. This involves interacting with learners to help them find answers for themselves, clarify and reflect on their own ideas, and indeed change their ideas. In terms of professional development this means facilitators must find out what the learners are thinking, accept their ideas, challenge them, promote discussion, work as co-researchers, provide resources, give feedback, create supportive and caring atmospheres for learning, and manage the professional development process (Bell, Pearson & Kirkwood, 1990).

4.4 Professional development as a process of change

An important aspect of constructivist learning that needs to be considered in relation to professional development is metacognition, in particular, developing an understanding of the process of learning, and accepting the associated feelings that occur with new learning. Change is a process and not an event (Hollingsworth, 1992; Daresh, 1989; Fullan, 1988b) and professional development is this process. It is a complex process which may include feelings of threat, as Richardson (1990, p.16) pointed out,

> *empowerment is threatening when teachers are asked to make changes in activities without being asked to examine their theoretical frameworks.*

It is important to enable people undergoing professional development to experience it as a meaningful process as their basic conceptions of education and skills are involved—that is, their occupational identity, their sense of competence, and their self-concept. The need and difficulty for individuals is to develop a sense of meaning about change (Fullan and Stiegelbauer, 1991).

Some aspects of the change process can be considered within Bell and Gilbert's (1993) three dimensions.

Within professional development there is a need to understand

i the realities of the status quo (Fullan and Stiegelbauer, 1991) as these are important constraining influences;

ii that innovations get adapted rather than adopted (Fullan, 1988b);

iii that the fundamental breakthrough occurs when participants understand the underlying conception and rationale of a new way that works better (Fullan, 1985a).

In personal development two factors stand out:

i change involves ambiguity, ambivalence, and uncertainty for the individual about the meaning of the change (Fullan, 1989b);

ii change is gradual and difficult, requires time and effort, is threatening and involves the risk of failure (Guskey, 1986).

In social development it has to be recognized that:

i change varies with different people even when they are working collaboratively;

ii alternative ideas need to be valued (Fullan and Stiegelbauer, 1991).

Change means coming to grips with new personal meaning, time and help being needed to cope with this. Even well-developed innovations represent new meaning and new learning for those who encounter them for the first time (Fullan and Miles, 1992). More complex reforms, such as restructuring, represent greater uncertainty because more is being attempted and the solution is not known in advance.

Whatever one's view of the process, Dalin (1978) contends that change can be gradual (evolutionary) or sudden (revolutionary). Apart from the speed of change it may involve changes in design or efficiency. Design is concerned with different practices while efficiency is concerned with improving existing practices. Drucker (1990) emphasizes that improvement (to do better what you already do reasonably well) and change (to do something different) are both essential.

Order of change

The order of change has been an issue discussed in the literature about the change process. The traditional approach to planning for change was based on the assumption that when teachers changed their beliefs, they would change their classroom practices. Guskey (1986) argues that teachers need, with the help of staff development, to change their practices first. He claims that after observing their students' learning outcomes change, teachers will change their beliefs and attitudes. This fits with his view (Guskey, 1988) that in changing to new strategies, most teachers believe that there has to be some benefit for them. Other writers (Fullan and Stiegelbauer, 1991; Fullan, 1989a; Lortie, 1975)

agree with Guskey's model and suggest that it has significant implications for planning. At the same time, it has to be acknowledged that change may remain at the superficial level. New practices may be employed *mechanically without understanding the principles and rationale of the change* (Fullan, 1985b, p. 201).

The traditional model and Guskey's are linear. It may be more useful to think of the various changes occurring to different extents at different times with different people and to assume to and fro movement rather than uni-directional movement.

Reasons for change

Another problematic issue in terms of the development process is the reasons for change. Guskey (1988) suggested that teachers change when they perceive a personal benefit—which may be improvements in student outcomes. Without a reason for change, teachers are likely to ignore and resist efforts made by others. Doyle and Ponder (1977, p.1) contend that the *practicality ethic* offers a key. *Messages which are seen as practical will be incorporated, at least tentatively, into teacher plans.* The ideas of plausibility at the start, intelligibility during learning, and the possibility of being fruitful are three of the criteria suggested by Posner, Strike, Hewson and Gerzog (1982) as likely to foster change.

Groupings for change

Ideal groupings for professional development often stimulates debate. Logan and Sachs (1991, p.307) defined in-service programmes as *learning collectives formed for periods of varying duration to achieve a specified task.* They said that this was true whether the group was based in-school or off-campus. They went on to explain that an *effective learning collective is a small, temporary group bonded through acts of mutually exploring aspects of common concern through a series of activities designed to help members both to reflect on and to plan their practice in disciplined ways* (p.307). Such collectives have much in common with the 'quality circles' suggested by Deming (1986) in the quality management context.

Rather than learning collectives, Rogers (1969, p.105) wrote about learning in groups where he had the role of non-directive facilitator. He said *when I have been able to transform a group - and here I mean all the members of a group, myself included - into a community of learners, then the excitement has been almost beyond belief to free*

curiosity; to permit individuals to go charging off in new directions dictated by their own interests; to unleash the sense of inquiry; to open everything to questioning and exploration; to recognize that everything is in process of change - here is an experience I can never forget.

Summary

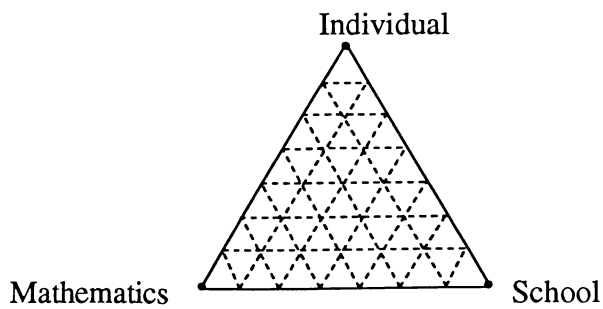
In summary, taking a constructivist viewpoint and seeing professional development as a learning/change process, it is desirable that participants understand how the process works, how people will feel during the process in terms of the personal, professional and social development, that the change process is not an orderly one which they might have expected, that different people have very different reasons for embracing (or not embracing) change, and that the grouping for change can have significant effects on the process.

4.5 Focus for professional development activities

Professional development is adult learning but, like all learning, it can be concerned with many different foci. Logan & Sachs (1991) listed three: national policy, school improvement, and individual growth. In mathematics education these foci become mathematics, school and the individual. Professional development activities may involve more than one of these and it may be useful to consider a grid (figure 4a) as a means of positioning any particular programme.

Figure 4a

A grid for positioning the focus of professional development activities.



Pressure for change

This grid can illustrate (by the distance from the apex) whether a change is due to internal conviction (of the individual) or external pressures (the subject or the school) or a mixture of the two. The importance of these varies from time to time and depends on the individual's status in the school and in mathematics education.
When the pressure for change is external it is likely that there will be:

i authoritative or imposed development,

ii a view that development involves compensation for deficiencies,
iii curriculum development before teacher development, and
iv development on a stop-start agenda as political needs arise.

With internal conviction there is a greater likelihood of

i collaborative or natural development,
ii building on strengths,
iii ongoing development, and
iv multiple perspectives existing.

While internal conviction may be favoured over imposed change, developments from an external source are more likely to achieve a design solution than an efficiency one. That is to say, a solution is likely to be achieved that replaces an old practice with a new practice rather than a solution which merely improves the efficiency of present practice. These are not mutually exclusive as design ideas from external sources can be presented to individuals and incorporated in their thinking.

The three foci (the individual, the school, and mathematics) are the basic ones but each can be extended. Many mathematics educators and documents list foci for development, including Pimm (1988), Jaworski (1988), the new curriculum (Ministry of Education, 1992b) and other curriculum documents and reports (National Council of Teachers of Mathematics, 1989; Department of Education, 1987c).

The main mathematics foci are

i the nature of mathematics,
ii the curriculum content,
iii the mathematical processes (communicating, modelling, problem-solving, reasoning, making connections, and using technology), and
iv related teaching and learning issues which are broader than mathematics and are listed under the subheading school.

School foci which link with mathematics education include

i learning theory (constructivism), and
ii teaching issues (context, relevance, questioning, learning activities, appropriate assessment).

Broader issues include

iii school improvement (and restructuring),
iv classroom management,
v equity issues (gender, ethnicity, ability), and
vi political issues (assessment, relevance, hidden curriculum).

Two of the above issues of particular importance are learning theory and context/ relevance. Elliot (1989) claims that educational practices are informed by many traditions but the academic (teacher) should not seek to avoid commitment to a particular outlook. A facilitator's job is to help teachers committed to a one tradition to articulate, clarify and discuss their reasoning. In doing so the facilitaor will welcome dialogue with the advocates of alternative ideas and encourage teachers to consider these as a way of deepening their understanding about practice.

New curriculum documents either explicitly (NCTM, 1989), or implicitly (Ministry of Education, 1992a), refer to the mathematical process *making connections* which implies contexts. The connections include linking with other subjects, with everyday life, and with the interests of students. Context is seen as being part of mathematics, not merely an add on. Rodrigues (1992), researching context in chemistry education, discussed four reasons for considering context - motivation, chemical reality, social awareness, and cognition. This is a useful classification (with the word mathematical substituted for chemical). She went on to define context as *a vehicle that enables the student to link their existing experiences to the concepts being taught* and described how students went to and fro from context to theory in situations where they could link the concrete with the abstract.

At the individual level personal issues are a focus for professional development activities. These include
i responding to change,
ii personal development (assertiveness, relationship skills), and
iii career development (improving effectiveness in the current job, increasing a teacher's range of abilities, and taking on additional responsibilities (Thomas, 1991)).

The focus for development can also be described by its purpose. Schlechty and Whitford (1983, in Smylie, 1988, p.2) observe that staff

development can serve at least three different functions:

i an *establishing* function to promote organizational change through the introduction of new programmes, technologies, and procedures in schools and school districts;

ii a *maintenance* function to change practice to ensure compliance with preferred administrative routines and to support organizationally preferred modes of operation;

iii an *enhancement* function to improve teachers' performance in the classroom.

Schlechty and Whitford found that most staff development provided by schools and school districts serves a maintenance function. In New Zealand there appears to be more of a balance with different providers focusing on different functions.

4.6 Summary

The focus of this chapter has been to provide an overview of a number of issues to do with professional development that have emerged from recent research. These indicate the problematic nature of professional development. In many of the issues there are divisions between traditional views and those of some mathematics educators, and bridging these with sensitivity presents a challenge to development planners and providers.

The change in learning theory from behaviourism to constructivism has contributed to the debate. It is assumed that it impacts on adult learning in the same way that it does on learning by young children. Constructivism has also raised questions about the nature of mathematics and the way it is learnt and taught. Consequently constructivist learning theory features in professional development work in two ways. It is a focus of study, and, it influences the way that professional development is provided. The metacognition dimension inherent in constructivism stimulates an interest in understanding the process of professional development itself. Other factors that determine a teacher's development needs, and influence they way the teacher learns, include career stage, life experiences and critical incidents.

The main foci for development are the school, the subject mathematics, and individual growth. All of these are viewed from a learning or

growth perspective rather than one of imposed change. All three foci are in a state of flux at present. Significant changes include an emphasis on mathematical processes, new educational administrative systems as we move into a postmodern society, and individuals being affected by the more general changes in society.

Ideas that emerge as important guidelines for planners of effective development include

i ongoing development;
ii building on the prior experiences and knowledge of participants;
iii catering for a range of development interests and needs in professional, personal and social respects; and
iv linking theory, practice, beliefs attitudes and behaviours in a consistent way.

To ensure that professional development is effective, there is also a need to consider the range of necessary components, ways that each might be provided, and how these components fit together. These are the focus of the next chapter.

Chapter 5 COMPONENTS OF THE DEVELOPMENT PROCESS

5.1 Introduction 45
5.2 Components of professional development programmes 45
5.3 Types of professional development activity 53
5.4 Five models for professional development 55
5.5 Summary 57

5.1 Introduction

In this chapter the focus moves from the professional development process to the format for development programmes. Several aspects that have arisen already and other components that are needed in development programmes are fitted together. Some types of development activity are considered and five models that might be used are introduced. In chapter 6 the focus moves to more specific variables that influence development.

5.2 Components of professional development programmes

In this section the general components of professional development are brought together in a format for development programmes. Such a format needs to be considered to help ensure that development will be effective and overcome the difficulties caused by time being needed for change, change being accompanied by anxiety and uncertainty, change involving learning new skills through practice, learning requiring feedback, and the breakthrough occurring when people understand the underlying concepts and rationale with respect to change (Fullan, 1985b).

Bolam (1987, p.41) cites Joyce and Showers (1980) who distinguished between five components for development programmes and between four levels of impact that development can have.

Five principal training methods or components:

- *presentation/description of new skills and underlying theory;*
- *modelling the new skills;*
- *practising the new skills in simulated and controlled conditions;*
- *feedback on performance of new skills in simulated and /or real settings,*
- *teaching for application, transfer and integration via in-classroom and in-school assistance from peers and from trainers.*

Four potential levels of impact:

- *general awareness of the new skills;*
- *organized knowledge of the concepts and theory underlying the skills;*
- *learning of principles and skills ready for action;*
- *transfer and application of the new skills to the classroom and integration into the teaching repertoire.*

Bolam linked these in a matrix (table 5a). The ticks indicate the components which are needed to achieve particular levels of impact.

Table 5a Training components and levels of impact (Bolam, 1987, p. 42)

Level of impact / Training component	General awareness of new skills	Organized knowledge of underlying concepts and theory	Learning of new skills	Application on-the-job
Presentation / description of new skills	√	√	√	√
Modelling the new skills		√	√	√
Practice in simulated settings			√	√
Feedback on performance in simulated or real settings			√	√
Coaching/assistance on-the-job				√

These components of development activities overlap rather than being discrete and provide a useful framework for a consideration of development programmes. The components and levels of impact generally fit with the constructivist learning process if 'presentation' and 'modelling' are interpreted in a non-transmissive way.

The table provides for a wider potential range of courses than traditional courses that often focused mainly on telling or sharing which correspond to presenting and modelling in this table. Experimenting (trying out new ideas or activities) has been a focus at some recent development workshops, courses and conferences and this might be thought of as practicing and getting feedback in simulated settings. Bolam has extended these components to include supportive assistance on the job to enable application of the new learning.

The literature about the personal and social dimensions, the need for personal autonomy, the need to establish ownership of development (Bell, 1993a), and the view that development is a process, suggests that while Bolam's list of components is useful, it needs to be extended with two preliminary stages, an implementing stage, and two final stages that focus on learning and empowering teachers.

Table 5b incorporates Bolam's ideas in a reorganized manner and extends them to include the related ideas from Bell (1993a), Leinwand (1992), Farmer, Buckmaster, and LeGrand (1992). The aspects in table 5b do not form a linear sequence: considerable movement between them will occur and considerable overlap exists within both aspects and actions.

Table 5b Some aspects and actions in the professional development process.

aspects	actions (by facilitator, group, and/or learner)
preparing	- accepting one's teaching as problematic - seeing isolation as problematic
planning	- developing a vision - considering the status quo - dealing with restraints to development
initiating	- finding out about new activities - introducing/describing new skills and ideas - considering underlying theoretical implications - modelling new skills - observing behavioural and cognitive modelling - exploring alternatives - learning more about new activities - anecdoting
experimenting	- practising in simulated settings and trialling in the classroom (and articulating their thoughts before, during and after this practice) - reflecting on performance - getting/giving feedback on performance - coping with ambiguity, anxiety and uncertainty - getting/giving support
integrating	- receiving/giving assistance on the job - valuing collaborative ways of working - reorganizing intellectual experiences - linking activities with theoretical framework
learning	- building activities into practice - adjusting one's theoretical framework
empowering	- developing ideas and classroom practice - feeling empowered - initiating collaborative ways of working. - initiating other development activities.

Each of these aspects is briefly described.

Preparing

The preparation aspect is concerned with the initial stage of building a culture for development. It involves individual teachers coming to an appreciation of their need to be involved in development. It may occur during the initial implementation of a programme or it may precede it and provide some impetus for the establishment of the programme

Planning

Planning involves establishing an appreciation of the status quo and a sense of direction for development. Such a vision will only be partially formed as involvement in a programme is likely to lead to this vision being developed further or modified. The planning aspect involves many management questions which are related to the restraints on development.

Initiating

The initiating aspect of development is concerned with finding out about new ideas that might be considered. These include ideas about curriculum (content, mathematical processes, and context), and about learning and teaching. When ideas emerge they need to be explored in terms of their underlying theory and their usefulness in class because it is sometimes easy to adopt ideas that seem to fit with the established vision, but which have contradictory consequences when implemented. An example of this is when teachers move to teaching consistent with constructivist learning principles but retain behaviourist assessment.

Sources of new ideas, new skills and new activities include:

- newspapers, books, radio and television (Williams, 1991),
- teacher and study guides (Williams, 1991),
- textbooks and assessment details (National Research Council, 1990),
- professional readings, perhaps as part of a structured course (Peter, Clarke, Carlin and Harmes, 1992),
- cooperative sharing sessions or anecdoting (Bell, 1993b; Jaworski et al, 1991; Mousley and Rice, 1989),
- visiting and observing other classrooms (Bell, 1993a)
- outside advisers, consultants, researchers and curriculum specialists (Mousley and Rice, 1989), and
- modelling (in classroom, role-play situation, with computers, video, or a written classroom activity).

Many of these sources can be used to stimulate and facilitate teacher learning. (They can also be used to control and disempower teachers in accordance with a 'deficit' view of teachers' knowledge of mathematics teaching and learning.) The sources need to be used actively and creatively by participants in programmes (Mousley and Rice, 1989).

Erickson and MacKinnon (1990) believe that the use of pedagogical exemplars is an effective method in development. Woods (1987) also stresses modelling as a means of changing teaching methods by giving teachers new experiences. Consequently, when new ideas and activities are presented the presentation should be done using the same (constructivist) principles of learning that are being promulgated in the development programme.

Experimenting

Experimenting involves trying out new ideas and new activities, practising with these new activities, and articulating one's thoughts while practising. It also involves reflecting, getting and giving feedback, coping with the resulting ambiguity, anxiety and uncertainty, and getting and giving support.

Much of this can be done with others and in a context close to the classroom to overcome a difficulty identified by (Guskey, 1986, p.6)

> *development activities undertaken in isolation from teachers' ongoing classroom responsibilities seldom have much impact on teaching practices or student learning.*

This suggests undertaking specified classroom tasks and then reflecting on and sharing the experience (Peter, Clarke, Carlin and Harmes, 1992), or it may involve developing a unit of work based on the approach, using it, evaluating it with their own students, and reporting back (Bell, Pearson and Kirkwood, 1991).

The reason for this practice phase is to enable teachers to gain insights into the learning process. To achieve this the structure, atmosphere and delivery, including the form of evaluation of the course should be as near as possible to the ideas and skills it is hoped the teachers will get from the course and model in their own classrooms (Baird and Mitchell, 1986).

Reflection and feedback are aspects of the experimenting stage. The importance of feedback was recognized by Daresh (1989) who claimed that inadequate feedback is one barrier to change. Feedback can be obtained from oneself (reflection), from one's students, or from colleagues. Activities that promote feedback and support reflection include:

- using journals (Smyth, 1992; Peter, Clarke, Carlin and Harmes, 1992; Oberg and Underwood, 1989; Holly and Mcloughlin, 1988b),
- writing or sharing self narratives (Diamond, 1991; Goodson, 1991),
- considering student feedback,
- sharing reciprocal classroom visits (Bell, 1993a),
- discussing with critical friends (Goldenberg and Gallimore, 1991),
- using sharing sessions Killion, 1993; Mousley and Rice, 1989),
- anecdoting (Bell, 1993b; Hollingsworth, 1992; Jackson, 1992; Jaworski et al, 1991), and
- participating in reviews (appraisals, inspections).

Another aspect of the experimenting stage is giving and getting support. Teachers need support for change because old routines dominate and help is needed to develop new routines (Day, 1987). Fullan (1985a) believes that successful change involves pressure, but sees this as pressure through interaction with peers and other technical and administrative leaders. This pressure, when positive, can be interpreted as support which increases expectations and reduces isolation. Assistance and support come in many forms. Croft and Beresford (1992) and Day (1987) have looked at these and combining their analyses it seems there are four types of support: professional, personal, social and practical.

Some ways of supporting and assisting have already been discussed. These include sharing (new ideas and resources), visiting and observing in other classrooms, using outside experts, getting feedback, having critical friends, and anecdoting. Other ways (see next page) have been suggested by numerous authors (Baird and Mitchell, 1986; Bell, 1993a; Bell, Pearson and Kirkwood, 1991; Day, 1987; Frampton, 1991; Fullan, 1989a; Fullan and Stiegelbauer, 1991; Leinwand, 1992; McLaughlin, 1990; Mousley and Rice, 1989; Pratt, 1988; Rodriguez, 1991; Silvester 1989; Simon and Schifter, 1991; Skemp, 1989).

At the professional level some ways of providing support include

- developing informal networks to get round the difficulties of formal hierarchies (Dalin, 1978),
- encouraging participation in professional networks and mathematics associations,
- encouraging participation in development initiatives,
- facilitating sharing of teaching activities, solutions to problems, and theoretical ideas and experiences (Bell, 1993b),
- encouraging attendance at national and international conferences,
- involving participants in collaborative planning, and
- allowing people to react, to form their own position, and to interact with others.

At the personal level some ways of supporting and assisting are

- helping participants recognize and accept ambiguity, uncertainty and choice (Nias, 1987),
- encouraging participants to accept and disclose beliefs and feelings (Bell, 1993b),
- ensuring that individuals control the pace of change, and
- prizing, accepting, and trusting (Rogers ,1969).

At the social level support and assistance is facilitated by

- encouraging 'ad hoc' groups (Abercrombie, 1969, in Nias, 1987),
- ensuring that two or more people from each school are at a course, and
- building relationship skills.

At the practical level the assistance includes

- ensuring all can participate (including information, child care, transport, meeting places, advocacy),
- having a flexible structure, and
- providing resources (money and time).

Integrating

The integrating aspect of development involves providing and receiving assistance when new activities and skills are being used in classes and when the person implementing these is making sense of them with respect to prior experiences and theoretical ideas. One form of assistance that partially overlaps with the other aspects is supervision. Daresh (1989) described three forms of supervision:

i Nondirective supervision which involves listening, asking questions to draw out the teacher, encouraging talk about

problematic aspects of work, and offering a limited number of personal perceptions and thoughts about the difficulties expressed by the teacher.

ii Collaborative supervision which involves initiating discussions to explore solutions, prodding the teacher to resolve the problem and showing how to act, thus eliminating the problem.

iii Directive supervision which involves detailing exactly what must be done, explaining how it must be done to comply and delineating the conditions and consequences for the teacher's improvement.

Coaching is an alternative term used when discussing assistance. Joyce and Showers (1982, p.5) say that *like athletes, teachers will put newly learned skills to use if they are coached.* They defined coaching to include studying new skills within a theoretical background, seeing them modelled, having opportunities for practice and feedback.

Two actions in the integrating aspect are the reorganizing of intellectual experiences and the linking of activities with one's theoretical framework. These are important in terms of constructivism. They correspond to the Piagetian notions of accommodation and assimilation and to the notion of having a coherent framework of ideas. If reorganization and linking are not done then the new skills are likely to be soon discarded or forgotten.

Learning

The learning aspect differs from integrating in terms of permanency. While integration into practice means changing one's behaviour, learning refers also to changes in beliefs and attitudes. Such a change requires adjusting one's theoretical framework and this may occur a considerable time after the integration stage. When learning occurs ideas become part of the person and will be reflected in the person's activity. The learning and integrating aspects may develop in a parallel manner.

Empowering

The other aspect of the development process is empowering. This involves a person feeling able to take initiatives in developing ideas and activities, classroom practices and collaborative ways of working.

Summary

In summary, it is useful to consider seven aspects in the development process—preparing, planning, initiating, experimenting, integrating, learning and empowering, and to plan programme that facilitate these.

5.3 Types of professional development activity

Numerous writers (Begg, 1991a; Bell, 1993a; Day, 1991; Knott and Cole, 1989; Schrum, 1991; Williams, 1991) have considered various types of development activities. These are summarized in table 5c.

Table 5c Types of professional development activity.

type	subtype	examples
project	research	major research projects, action research, teacher research
	development project	curriculum and resource production, school scheme or course design, assessment project, needs appraisal, policy formulation
	exploratory study	
meetings	in-school	maths department, staff meetings, sessions with advisers
	local	mathematics association, networks
courses	conferences	national, international
	one-week	vacation-time, term-time
	sandwich/structured	
study	formal	full or part-time university, retraining
	informal	professional reading, teachers guide
		reflection (private)
		reflection (with critical friend)
peers	exchanging material	
	visits	within-school, with other schools, exchanges between schools
	in-school	collegial support, peer tutoring, delegated responsibilities
distance rural/urban	correspondence	printed material, audio & video cassettes, electronic bulletin boards
	broadcast	radio or television
	interactive	talkback, teleconference, e-mail
general	in-school	job-rotations (apprenticeships)
	broad-life experience	parenthood, travel, other jobs
	secondments	industry and commerce
	overseas experience	

These development activities are familiar in some form or other to teachers in high schools. They have been listed together so that they may be considered in terms of the emerging notions of constructivism, control of development, range of development needs, and the need to ensure that programmes include a number of components or aspects.

Another issue to consider when discussing types of development activity is the relationship between theory and practice. When considering this, McKeon (1952) identified four types of relationship between them. Two are relevant to professional development. These are the logistic and deliberative modes. In the logistic (procedural) mode theory and practice are kept separate; theory is the province of experts and is joined with practice by some science of human action. In the deliberative (problematic) mode theory and practice come together and solving problems becomes a task for all. At present in New Zealand, with central control of curriculum and assessment, the logistic mode dominates (Holt, 1993) and the RDD (research/development/ dissemination) model is an example of this. However, with curriculum beginning to link content and learning theory and with the constructivists' emphasis on making connections, there is a need to move to a deliberative mode. But the deliberative mode assumes that a professional culture has been established in schools, that teachers can and want to link theory with practice, and they desire more collaborative learning (Holt, 1993).

In considering whether the development activities in table 5c are appropriate, criteria that promote constructivist learning by the participants need to be developed. Questions such as the following may assist such development:

i Do they provide or contribute to ongoing and participant-controlled learning rather than imposed change?

ii Do they fit the deliberative mode in terms of involving both theory and practice?

iii Do they incorporate most of the aspects needed for development?

iv Do they cater for the broad range of development needs that exist within a mathematics staff at different career stages?

v Do they fit with constructivism?

5.4 Five models for professional development

The development activities considered in the previous section can be used within various models for development. In this section some models are described that could be considered in the early preparation and planning stages of development. Dalin (1978) outlined four:

1 the research, development, diffusion model (RDD)
2 the problem-solving model
3 the social-interaction model, and
4 the linkage model which is a synthesis of the other three.

A fifth, the *evolutionary planning* model, was discussed by Louis and Miles (1990). It offers an alternative to top-down and goal-based planning but shares some common aspects with the other models.

RDD

The research, development, diffusion model breaks the whole development process into three parts in terms of time and people involved. Firstly research is done by one group of people; then a project team is appointed to plan and prepare resources and teacher development activities to incorporate the ideas from the research; finally the dissemination occurs and involves the teachers in the targeted group. Five assumptions are usually made about the RDD model:

i the sequence is rational,
ii planning is spread over a considerable-time span,
iii there is a division of labour between the three stages,
iv the 'consumer' will accept and adopt the innovation,
v high initial development cost is typical.

The RDD model usually depends on ideas from an external source being imposed on teachers. Dalin (1978, p.71) writes, there are *serious questions about the effectiveness of a predominantly RD and D approach to the promotion of innovation and improvement of institutional practice.* This model has been in use for many years with such developments as the introduction of 'new maths'. While doubts about the model's effectiveness exist, it does seem to have influenced many teachers. The RDD model tends to separate theory from practice and usually addresses a limited range of teacher needs.

Problem-solving

In the problem-solving model the stages are:

1 identifying and analysing the problem
2 obtaining relevant information and discussing its implications

3 forming alternatives for action
4 testing the feasibility of alternatives
5 adopting and implementing the selected alternative.

This model uses rational thinking as the basis for change within a school (or group of schools). The concerns addressed may be imposed or may arise from the participants, and the participants may divide into smaller groups to address problems that only concern some of them. An example of development using the problem-solving model is when a group of teachers decide that their classroom management needs improving. They analyse their management methods to focus their concern, read or discuss classroom management with others, decide on some strategies to trial, and incorporate them fully into their teaching when the strategies seem to be successful.

Social interaction

The social-interaction model depends on networks and interpersonal influences. The new ideas often originate outside the adopting system and an individual's membership and position within the networks are likely to influence adoption. Visiting other schools, attending professional association meetings, and inviting advisers to schools increase social interaction which may provide opportunities for introducing new and more effective educational practices from outside.

While the above description of this model emphasizes the interaction outside the (mathematics) department, it is the interactions within the department that take the development past the new ideas stage.

An example of the social interaction approach is when a teacher attending a conference hears about a new emphasis in mathematics teaching, for example, investigations. On returning to school the teacher discusses this with colleagues and they try some investigations in their teaching. If the teacher has a significant position inside the department (for example, head of department) then considerable pressure may be added to the social interactions to ensure that investigations are adopted in the school scheme.

Linkage

The linkage model synthesizes some features of the other models. It begins with identifying a problem but the alternative solutions usually come from outsiders and considerable attention is given to interactions between researchers, developers, practitioners, and consumers.

An example of the linkage scheme would be in the introduction of teaching methods that fit with constructivism. Some of these ideas might have originated from a curriculum developed with an RDD model, but the need to find out about such methods may have arisen from a dissatisfaction or problems with existing teaching. The process is likely to involve linkages between researchers and teachers and the responses of all concerned will be relevant.

Evolutionary planning

The evolutionary planning model is based on three premises (Louis and Miles, 1990):

i act—then plan

ii pay less attention to goals and more to inspiration

iii reflect on the relationship between action and improvement.

The model assumes shared control by participants and may get started in a small way with experimentation. It may build on ideas that arise from external authorities as the RDD model does, or from a problem solving approach. Alternatively, stimulus may come from the experiences of the participants or from a quest for improvement. The model involves social interaction as all the participants (perhaps a department) form the group that is evolving. This model seems to fit with constructivism in terms of valuing prior experience and knowledge, it is flexible and it combines features of the other models.

Selecting models

An appropriate time to consider models for professional development is during the planning stages. The five models listed above offer a range of options. The linkage model brings together aspects from the first three. It and the evolutionary planning model both offer approaches which teachers are likely to feel comfortable with.

5.5 Summary

This chapter broadens the professional development process of chapter four to describe formats for professional development, including components or aspects of programmes that need to be included to ensure that learning occurs. Types of development activities, and possible models for development have been considered.

Whereas chapter four revealed the need for ongoing development that:

i builds on prior experiences,
ii caters for a range of needs, and
iii integrates theory and practice,

this chapter identifies essential development components. These include:

i activities that facilitate the preparation and planning of development;
ii the initiation of new alternatives;
iii experimentation with these new activities and ideas;
iv integration of them into one's practice;
v learning that ensures that the ideas are linked into one's theoretical framework; and
vi empowerment of participants so that they are able to take the initiative in terms of future growth.

Additionally the types of development activity and models for development that could be considered by planners have been introduced.

Specific variables that influence professional development as revealed in the literature are reported in the next chapter (chapter 6).

Chapter 6 SOME VARIABLES IN PROFESSIONAL DEVELOPMENT

6.0 Contents

6.1 Introduction 59
6.2 Responsibility and leadership 62
6.3 Providers 70
6.4 Location 73
6.5 Time 75
6.6 Resources 76
6.7 Affective influences 78
6.8 Some economic considerations: costs and effectiveness 80
6.9 Summary 83

6.1 Introduction

Chapter four discussed the process of professional development and chapter five the format of the development process was discussed. In this chapter specific variables that influence professional development in New Zealand in the early 1990s are considered. The reasons for considering these variables are because

i they are likely to influence the decision whether the main focus of professional development should be in-school work,

ii they reflect some of the concerns that emerged from the data in part C of this study (chapters 11–13), and

ii the management of professional development has undergone considerable change since the 1989 restructuring of educational administration and school managers need to be aware of them.

This restructuring was referred to in 1.3 (p.5). It affected mathematics teachers first because the mathematics curriculum was the first to be reviewed since the restructuring. Prior to 1989 schools had very little direct control over professional development, but now most professional development funds and the control of teacher development has been devolved to schools.

Rate of change

With restructuring, devolution of responsibility for development, a new mathematics curriculum, and changing assessment procedures, the researcher's observation is that many teachers are concerned about the apparently increasing rate of change that affects them and many aspects of society, including schools. The hope is that the rate will decrease but, in Capper's (1992) view

> *Pedagogical and curriculum change is endemic, continuous and without any foreseeable prospect of stabilization. ...*

the consequence of this is we have no choice, we must start changing and keep changing, not expect to stop changing, and we must make the most of existing resources—there is no alternative.

Capper went on to explain how different aspects of change occur at different rates and suggested that these lead to increased tensions as the gaps between the various aspects increase. He clearly implied that professional development is not a luxury but needs to be accepted in education to help teachers cope with the inevitable changes.

Part of the rapid change is caused by imposed restructuring of education, curriculum and assessment. Lieberman and Miller (1990) claim that it is linked with initiatives to improve the preparation and development of teachers and, in the long term, with improved student outcomes but there is no evidence to support that view in New Zealand. In the present restructuring two aspects are stressed—standards and accountability. To some these imply a need for more assessment and this has been incorporated into curriculum documents in New Zealand (Ministry of Education, 1992b) and the United Kingdom (Department of Education and Science and the Welsh Office, 1989). The emphasis on assessment is not based on research, and is contrary to quality management principles (Deming, 1986). It can be argued that this emphasis may lead to a lowering of standards because of the time taken for testing and the narrowness of typical assessment objectives.

Critical theory

At the same time as the political restructuring of education, critical theorists such as Giroux and Apple are critical of the environment in which schools operate but optimistic that educators can transform schools into more equitable places for children. Rather than examining individuals to understand differences in achievement and failure in school, critical theorists examine the structure of schools, classroom practice, and the interactions between students and teachers (Bennett deMarrals, 1991). This fits well with Deming's (1986) message in the industrial sector. Transformation of schools is seen as a way of affecting society by making schools *sites of social change rather than social reproduction* (Bennett deMarrals, 1991, p.17).

Bennett deMarrals (1991) also points to the necessity of providing a different schooling which begins with a respect for the culture and social backgrounds of the students. This is supported by constructivists

who stress the importance of prior experience and knowledge, ethnomathematicians such as D'Ambrosio (1984), and the postmodern perspective (Giroux, 1990).

Approaches and goals

Change is being approached in two different ways. On the one hand restructuring is imposed with centralized control through assessment, while on the other teachers work towards improving the system and increasing professionalism. This second approach fits with constructivism and with the emphasis on teacher learning.

Critics of the present focus on assessment, and central control by setting up processes for formalising assessment procedures make the following points:

i this may stifle critical self-evaluation and ongoing classroom research (Tripp, 1988),

ii this may trivialize complex situations by attacking symptoms rather than the disease (Siemon, 1988; Beer, 1975),

iii this may work against continuous change (Capper, 1992; Deming, 1986).

In spite of the different approaches to change, the goals for education are not very different. The New Zealand Ministry of Education's (1991) goal is clear—

> *high quality teaching is the key to improving standards of achievement in education. The quality of teaching is maintained and enhanced through effective teacher development.*

Other writers (Cervero, 1992; Thomas, 1991; Fullan, Bennett and Rolheiser-Bennett, 1990) would agree with the Ministry's goal although they also look at influences such as school climate and management. Others have more specific goals for education, for example: Apple and Jungck (1992)—knowledge that, knowledge how, and knowledge to; Jaworski (1991), Oberg and Underwood (1989), Nias (1986)—self-discovery, congruence between person and practice, reflection, and growth. These are not in conflict with improvement in schools but they have a more personal dimension.

The different approaches and goals present a confusing picture for teachers. Related to approaches and goals is the question of responsibility for development and leadership.

6.2 Responsibility and Leadership

Who takes responsibility?

The question of leadership depends to some extent on whether the professional development arises from the individual (internally directed), from a Ministry directive (externally directed), or from some middle ground within the school (see figure 6a). The question is confused as Douglas (1991, p.105) says, because

> *people are both extolling the virtues of teachers as experts, and speaking the rhetoric of ownership, and yet at the same time using position power and resource power to exercise hierarchical or managerial control.*

Figure 6a

Possible organizers of professional development

Central (Ministry) directive	Local cluster initiated	Directive from school principal	Decision from school group	Individual teacher's decision
<———				———>
externally directed				internally directed

The question of responsibility and leadership for professional development is linked with who controls the development budget and where development will occur. In the United Kingdom the James Report (Department of Education and Science, 1972) recommended that schools should be the base for professional development. Bridges (1993) reports that during the 1980s the devolution process in England moved responsibility from the authorities to the schools. However Wright (1993) reports on the negative influence on school-based initiatives of the fast-tracked and legislated National Curriculum initiatives in England. This central control seems similar to that resulting from the devolution initiated here by the Picot Review and subsequent reports (Department of Education, 1988c and 1988d), and the influence of the current New Zealand curriculum initiatives.

Historically in New Zealand a number of groups have assumed responsibility for professional development. These include the ministry, local in-service committees, professional associations and networks, boards of trustees, principals, professional development coordinators, heads of department and individual teachers. While the groups outside the school can provide assistance, in terms of the components needed for development discussed in the last chapter, professional development needs to be closely linked with schools.

Within schools the principal is often viewed as the critical person in terms of development activities, but it has been argued that while *the principal is important, so are many other people* (Loucks-Horsley and Hergert, 1985) and that the principal *is not 'the key' to school improvement.*

In Britain the James Report (DES, 1972) suggested that each school should appoint a teacher as professional tutor with

> *particular responsibilities for helping new teachers on the staff and students in training receiving practical experience, as well as for co-ordinating the in-service training arrangements for all teachers in his school .*

The tasks of the professional tutor would be to link the school and other agencies engaged in in-service education and to co-ordinate all the staff development in the school (McMahon, 1981). In New Zealand many schools have made such an appointment and, in terms of the arguments of the previous two chapters, there is a need for the establishment of a culture for change and an ethos for development as well as the coordination role outlined above.

Within schools a third alternative exists. Heads of department have many duties which have been summarized in numerous publications (Department of Education, 1984a; Ashley et al, 1988). Marland and Hill (1981, cited in Ribbins, 1988) detailed these duties, including four that impinge directly on professional development:

- to assist the development of teachers' professional skills,
- to contribute to the initial training of student teachers,
- to take part in planning the school's overall curriculum, and to lead the planning of the curriculum within the department, and
- to assist in the overall leadership of the school.

Chapter thirteen (p.180) of this report indicates we see that most heads of department accept some responsibility for development, with some interpreting this as reacting to development opportunities rather than taking a proactive role.

A fourth option is for more responsibility for development to be accepted by individual teachers. While some teachers agree with this, others still have a traditional dependency view (based on directives

from the Ministry). This contrasts with Rudduck's (1988, p.207) observation that teachers have a predominantly professional outlook, she writes of the

> *self-image and spirit of new entrants to the profession (including of course mature entrants) who have a strong sense of professionalism, who see themselves as doers, innovators, new blood and who are committed to new pedagogies and collaborative modes of working. This group appears to be career-oriented (as an alternative, perhaps, to alliance with their world weary colleagues?), and also pro-innovation.*

Many authors (Clarke, 1992; Bradley, 1991; Candy, 1991; Douglas, 1991; Lather, 1991; Rodriguez, 1991; Richardson, 1990; Brandt, 1989; Scottish Education Department, 1989; Support for Innovation Project, 1989; Gibbons and Norman, 1987; Fernstermacher and Amarel, 1983; Rogers, 1969) have expanded on the need and the reasons for teachers to be involved in taking responsibility and leadership roles in professional development. Involvement fits within the philosophy of *participatory democracy* that Naisbitt (1982, p.175) promotes, and it fits with the idea of self-direction which Candy (1991) claims is linked with personal autonomy, self-management , learner control , and individual, non-institutional pursuit of learning.

If professional development is to take into account self-direction and participatory democracy, then it needs to be organized to allow and encourage these activities. They do not imply an absence of leadership, but the leadership style needs to promote empowerment of others. There are indications that in some countries this is beginning to happen. For example, in the Netherlands, Meeder (1992) spoke of the need for teacher support and autonomy, and of a tradition where teachers' decisions on what they want to change are heeded and where the facilitator's job being to provide materials, experiences, and other forms of support.

Leadership

Leadership in professional development is the process of bringing about needed change. According to Fullan and Miles (1992, p.7), leadership is important because change requires guidance.

> *Change initiatives do not run themselves. They require effort to be devoted to such tasks as monitoring implementation, keeping*

everyone informed of what's happening, linking multiple change projects (typical in most schools), locating unsolved problems, and taking coping action.

Styles of Leadership

Facilitative (or transformative) rather than traditional leadership has been mentioned as desirable. Derrington (1989) identified transitional steps in the move from traditional (technical and managerial) to transformative leadership. Her steps are shown in table 6a.

Table 6a

Transition in leadership style

Tradition	*Transition*	*Transformation*
The boss	The lone ranger	Parallel leadership
Branch manager	Hero	Hero maker
Adversarial	Competitive	Collegial
Views teachers as objectives for improvement	Views teachers as vehicles for improvement	Views teachers as partners for improvement
Works through directive	Works through small groups	Works through collaboration and power equalization
Rewards and punishes	Builds coalitions	Solves problems

These steps were developed for principals (school managers) but they identify styles which are relevant for development leaders, heads of mathematics departments and teachers. The transformation style suggests characteristics such as a concern for people, a high regard for relationships, good communication skills, a cooperative/collaborative approach, a willingness to live with ambiguity and uncertainty, and a view of development that considers empowerment as of prime importance. Robertson (1992) believes that these characteristics are usually exhibited by women more than by men, but she claims that women have not traditionally been valued in the appointment of professional leaders because appointments are often made by men with a framework involving competition, hierarchical power, dominance, conflict, declarations of certainty, over-confident reliance on rationality, quantifiable valued over subjective, and preference for instrumental and rational over affective and intuitive.

Motivation

One aspect of leadership in professional development involves taking into account why teachers get involved in development activities, whether they are seeking rewards, and what their motivation is. The need to consider motivation is stressed by Berman & McLaughlin (1978, cited in Guskey, 1986) who suggest that not considering what motivates teachers to engage in staff development is an important factor that contributes to the ineffectiveness of most staff development. They said that although teachers may be

> *"required" by certification or contractual agreements to take part in various forms of staff development, most teachers engage in staff development because they want to become better teachers* (p.6).

Bell and Pearson (1992) found the same; the desire to be better teachers and to have students engaged in better learning seemed the best motivator to get teachers involved in professional development.

If professional development is growth on the job, then motivation is to do with wanting to grow. While most teachers have a desire to grow, some may have found change uncomfortable, or may not wish to participate in activities because in the past the activities have not resulted in growth. In these cases one needs to consider whether pressure to change is justified and/or ethical. Loucks-Horsley and Hergert (1985) and Fullan (1989b) both claim that coercion is not always bad but that it will only be effective if participants can form their own position and receive help and assistance.

When change is imposed on schools the change often carries authority and imposes a pressure which challenges professional experience, judgement and expertise. This is viewed with disfavour by many older teachers who have experientially-based confidence and believe that they are the best qualified to make professional decisions (Sikes, 1992).

Some authors (Douglas, 1991; Daresh, 1989) believe that rewards help motivation, but Quinn (1989) suggests that they tend to work against the goals of development. Lortie (1975) claims that the culture of teachers does not emphasize the acquisition of extrinsic rewards and, according to Drucker (1990), this is similar in the culture of business.

Posner , Strike, Hewson and Gertzog (1982, p.214) have claimed that dissatisfaction, intelligibility, plausibility and fruitfulness are the four

conditions needed for a new concept to be accommodated by any learner. The first, dissatisfaction, is a motivator, while fruitfulness suggests an intrinsic "pay off" for the learner. Von Glasersfeld (1991, p.23) reinforced this idea when he said that

> *a way of thinking must not only be claimed feasible but, in order to become attractive, its advantages must be shown in action.*

Croft and Beresford (1992) have looked at why people want to be involved and suggest that most people want to influence decisions and outcomes, change the distribution of power, ensure equal access to marginalized groups and provide for broad-based involvement.

Ownership

Another aspect that leadership in professional development needs to take into account is ownership, that is, a personal and group understanding that development activities belong to the group rather than being imposed. If teachers are in a culture that supports their growth then motivation and ownership develop as part of accepting that culture. If change is imposed then motivation and ownership are issues for each initiative.

Taking responsibility for professional development is one aspect of developing ownership. One advantage of developing ownership is that the planning and organization of staff development continue after outsiders go away (Support for Innovation Project, 1989). It becomes part of an ongoing programme and starts the move from viewing professional development as imposed change to seeing it as teacher-learning. This provides motivation towards change that is personally founded, it is about meaning that is explored in relation to the self as well as in relation to the professional situation.

> *The phrase 'the ownership of change' has become part of a democratic rhetoric as inservice provision becomes more school-based. It is associated with so called 'bottom-up' initiatives after the 'top-down' models of the 60s and 70s* (Rudduck, 1988, p. 205).

Ownership allows teachers to work out the meaning for themselves of the changes before them (Fullan, 1989b), and it makes an activity less threatening. Fullan and Stiegelbauer (1991) talk of active initiation and

participation as well as ownership; Killion (1993) uses the term active involvement to express the same idea.

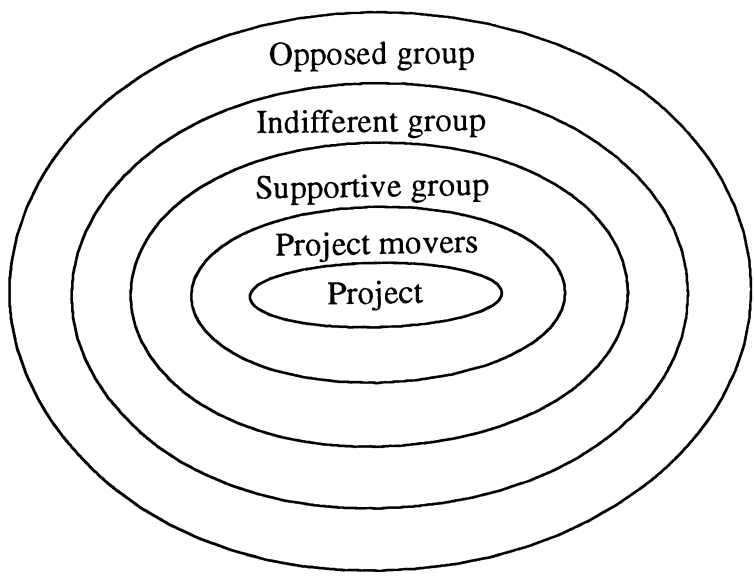
Ownership is not created at the beginning of a project; it builds and develops over time with involvement in a programme (Loucks-Horsley & Hergert, 1985). In successful development activities, according to Guskey (1986), ownership develops mainly after implementation has taken place. This implies that throughout all stages of any project, efforts need to be made to allow people to develop ownership. Tests of the sincerity of the management in wanting this ownership to develop are the availability of time, the significance of the issues involved, the treatment of dissent, the sharing of relevant information, and the response to suggestions (Judson, 1991).

Involvement

Linked to ownership is involvement. If ownership exists then involvement is not a problem but in many instances getting people involved precedes developing a sense of ownership. Guskey (1986) claims that most teachers want to be involved but Lowe (1989) suggests that many need convincing. The middle ground might be that within a school some teachers will be for an initiative while others will have different feelings. Stake, Shapson and Russell (1987) summarize such a range of positions that is likely to emerge with any development or within an ongoing project (figure 6b).

Figure 6b

Practitioners populations surrounding an in-school change project (modified from Stake, Shapson and Russell, 1987, p 198)



Facilitation

Another aspect of leadership is facilitation. Specific projects and ongoing development need facilitation, in particular at the start of an initiative. This may be provided by an outsider but if the emphasis is on school development, the role often falls to the head of department. Peter, Clarke, Carlin and Harmes (1992) stress this role of the school-based change agent as being an important factor supporting change. Guskey (1986) outlines the required characteristics: the facilitator must encourage and sustain the change, must be seen as credible by those responsible for implementation, must be articulate and charismatic, and must emphasize the practicality of the new practices (Guskey, 1986).

One role of the facilitator is manager, that is, making sure groups meet by arranging a venue and telling people about the meetings. Other roles required for effective group functioning have been outlined by Knowles (1990, p.153)—see table 6b. While the facilitator may take on some of these, others need to be encouraged from the participants.

Table 6b

Typical roles required for effective group functioning (Knowles, 1990)

Role	Function
technical expert	provides expert or technical knowledge
creative thinker	supplies new ideas and novel solutions
critical thinker	analyses and evaluates, is the realist in the group
social integrator	maintains relationships, conciliates
humorist	keeps activity enjoyable, eases tension
leader	co-ordinates and controls, speaks for the group

Knowles (1990) also outlined some negative social roles which a facilitator needs to ensure do not develop in a group. These are the status seeker who strives to be the centre of attention, the antagonist who deflates the status of others, the withholder who denies the group relevant information, and the cynic who undermines group confidence.

The facilitator's role is a tricky one—the person is likely to be tempted to intervene to speed things up when there is resistance by some staff in the form of direct opposition or diversionary tactics (Support for Innovation Project, 1989). It requires considerable skill and time to accept the legitimacy of the resistance and work through it, or otherwise accommodate it.

External or internal leadership

The leadership of professional development can come from within the school or from external providers. Because of the focus on school improvement, subject concerns, and individual teachers, and because of the way that high schools have traditionally been organized, the head of the mathematics department is usually the person to provide leadership within the department. There will be exceptions to this; small schools cluster responsibilities differently, and in larger schools where there is more than one position of responsibility within the department, leadership may be delegated. The management of a cross-school initiative is another exception. This may be led by a group which is likely to be school-wide and include teachers, department heads, administrators, students and parents (Fullan and Miles, 1992).

The importance of the head of department in providing leadership has been outlined in handbooks for them (Department of Education, 1984a; Ashley et al, 1988), by the Cockcroft Committee (DES and WO, 1982) and by Ernest (1989b). Ernest suggests that one of the three most important functions of the HOD mathematics is the provision of an in-service programme for staff development.

6.3 Providers

A further variable in professional development is the nature of the providers of development. Providers may be the people with new ideas, activities or specialist skills, they may provide assistance, support or feedback, and they may also facilitate or lead the development. The providers of development have changed in recent years in New Zealand. Providers of in-service may be the leaders or the facilitators of development programmes, they may be colleagues from within a school with particular expertise, or they may be outsiders. Dean (1991) has written about in-service providers from outside the school who could contribute. These are listed in table 6c.

Fullan and Stiegelbauer (1991) and Eraut (1977) listed some possible roles for outside providers to give assistance: subject consultant, curriculum coordinator, program adviser, resource provider, change agent, project director, link agent, promoter, career agent, ideas man, inspector/evaluator, legitimator, process helper, counsellor, and organization development specialist.

Table 6c Possible in-service providers from outside the school

Possible providers	Activities that providers might use
Higher education staff	lectures (one-offs or series) courses for a certificate, diploma or degree consultancy over particular aspects of the school's work evaluation action research classroom observation exchange arrangements and involvement of students
Advisers and inspectors	advice on practice advice on organization and management advice on in-service provision for school based work contribution to an in-service programme
Advisory teachers	advice on classroom practice advice on materials, equipment and organization work with pupils in the classroom lecture on classroom practice
Teachers from other schools	specific training in particular areas of work lectures on particular classroom work
Local industry	the provision of places on the firm's own courses the provision of work experience for teachers information about the firm's development programme

The Support for Innovation Project (1989) suggested four ways in which outsiders can offer support :

- Process consultancy (setting up and managing the process)
- Critical friendship (offering an objective view, someone to bounce ideas off and to share the strains and the triumphs with)
- Validation (bringing knowledge that other schools share the problem, giving encouragement and praise, and reflecting progress made)
- Internal and external linkage (bringing the school into networks of good practice).

Other ways that outsiders can help include:

- allowing visits to their classrooms and schools
- having teachers from other school visit your classroom and providing feedback
- providing courses
- up-dating teachers in specific curricular areas
- providing personal study opportunities over an extended period.

There are difficulties with outside help caused by people who:
- reinforce the top-down or dependency model;
- call themselves 'experts' but lack appropriate training;
- stress their expertise rather than what the teachers already know;
- charge for their time , thus making time a critical factor;
- need to be seen to be doing something in order to justify to the school that their time and energy are being repaid in some concrete way;
- do not understand the culture of the school or the background and idiosyncrasies of the teachers; and
- overlook their clients' concerns and attempt to change clients

> *irrespective of the needs or wishes of the client, because apparent change in people is what makes a change agent "feel good". Furthermore, they may be convinced that change is necessary when, in fact, there is little or no evidence to support this view* (Robinson, 1989, p.279).

Resources such as teacher guides, texts, videos, and journals are a more acceptable form of outside influence, they are not high pressure, they exert no time pressures, no one loses face if the ideas in them are rejected, and the ideas can be accommodated into the school comparatively easily if they are seen as desirable. Ideas from such resources are likely to need the support of in-school change agents if they are to be implemented.

New programmes and practices imported from somewhere else offer a viable, cost-effective ... alternative to major development efforts (Loucks-Horsley and Hergert, 1985, p.ix, in Fullan, 1986, p.79), but they are likely to require modification before they are acceptable to the country, the teachers, and the students. Again, inside expertise must support any development that originates elsewhere.

Perhaps the best use of outside help is to assist the heads of department develop the facilitative skills needed to manage professional development. Frampton (1991) reports on one programme director who noted the importance of defining and recognizing the qualities of inside facilitators, and spent time preparing them for their role.

In-school help

To encourage the aspect of empowerment in professional development, schools need to rely principally on their own staff and not depend on outside providers. The Support for Innovation Project (1989, in Bradley, 1991, pp.104–105) claims that

> *schools are in a better position than outsiders to develop means of addressing needs of members of staff who are suspicious of, and resistant to, outsiders interfering in the school.*

They believe that

> *every member of staff has something to offer her/his colleagues and this can be encouraged, rather than handing over to an outside 'expert'.*

As the DES reports (1990, p.15) the central authority can augment the work in schools

> *by offering regional support, and by establishing general guidelines. It would, however, serve no good purpose if they merely encourage a heavy 'top down' approach to what is essentially a school-based process.*

Training the trainers

When in-school experts are to be used to manage change, they may need training to prepare them for the task and to help them develop credibility as developers. To help establish the in-school perspective, training activities could be provided by the school's principal or the development coordinator. A possible focus for such the training of facilitative leaders is provided by Rogers (1961) who describes how his view of himself as facilitator changed. In his early professional years he asked the question,

> *How can I treat, or cure, or change this person?* (p.32)

Later he preferred to ask:

> *How can I provide a relationship which this person may use for his own personal growth?* (p.32)

6.4 Location

If one assumes that professional development is an ongoing and continuous process then the question of location becomes more of an issue than it was for short courses. It involves convenience and economics. The in-school option is the cheapest in terms of travel, and therefore time; and the cost of expertise is regarded by administrators as zero when colleagues are used. In-school development is virtually the only option which can offer continuity.

Within a school the mathematics department is usually seen as the convenient unit for professional development, but a department may display little unity, lack leadership, and mathematics teachers may identify with other groups within the school. The department may not be the appropriate starting point. Postmodernism suggests that a variety of interests and positions, and diversity are to be valued (Hargreaves, 1994b). Further, since many problems are not department problems but involve the school, a wider base of ideas might be desirable.

Many people prefer to be with peers rather than with their supervisors or with people of considerably different ages, points of view, experiences and needs. This has been evidenced by the formation of gender and Maori networks in mathematics education in New Zealand, the development of women in middle management groups (Levine, 1987), and by the success of principal groups. This suggests that peer groupings may be effective units for some development. In an average or larger size high school this offers an alternative to departments as working units for in-school development.

In considering location for development activities, Wideen (1987) argues for in-school development. Guskey (1986, p.6) comes to a similar conclusion. He says that

> *development activities undertaken in isolation from teachers' ongoing classroom responsibilities seldom have much impact on teaching practices or student learning* .

With this in mind, with the concern for development within the school and for leadership to be provided by the head of department, the natural location to site the majority of development activities seems to be within the school. This is desirable in terms of convenience and because most development activities are related to work within the school. There may be a need to get away from school for activities such as a planning retreat or a one-day writing project where freedom from interruptions is important. Teachers will also get away from the school for some of the activities which require communication with colleagues beyond the school—professional association meetings and conferences.

Baird and Northfield (1992, p.294) are basically in agreement and argue that *given appropriate conditions and support, schools have the*

capacity and the commitment to improve themselves. Dalin (1978) takes a middle position, claiming that imposed and institution-based development are both necessary but are not enough. He suggests three development strategies—a whole school development programme, networking, and system support—at possibly three locations (in school, at local meetings, and at national meetings).

6.5 Time

Another variable influencing professional development is time. Three aspects of time affect development activities:

i timing (when should development sessions be held?)
ii duration (how long should a development project take?) and
iii frequency (what should be the time between sessions?)

Timing

A question to be considered by professional development managers is when should development sessions be held? The question of timing is often neglected yet many teachers, especially women and solo-parents, have child-care responsibilities which make attendance at meetings difficult if these are not very regular or within school hours (Lieberman and Miller, 1990). One solution already mentioned by Douglas (1991) is to ensure that professional development and school development are built into the timetable within the normal school hours or by using specific days. This was done in Scotland on the recommendation of the Main Committee (Scottish Education Department, 1989).

Duration

How long should a development project take? While short courses may provide opportunities to make people aware of new ideas, human growth and development are recognized to require time (Wildman and Miles, 1987; Hamachek, 1987 cited in McCarty, 1993). The general feeling is that the 'quick-fix' workshop will not be sufficient to achieve either the desired changes caused by new policy or the development of an ethos for change. One-day courses or conferences may be useful as starting points or as part of an ongoing programme but it needs to be accepted that teachers need considerable time (two or three years) to trial, discuss, reflect on, adopt, and institutionalize significant changes (McCarty, 1993; Goldenberg and Gallimore, 1991; Pegg and Redden, 1991; Fullan, 1989b, 1988a, 1985a; Baird and Mitchell, 1986; Guskey, 1986; Taylor, 1986; Price and Gawronski, 1981).

Shorter periods for development might be relevant for specific projects. Dumser (1991) reported on a 6–8 week mini-sabbatical that allowed her to be freed from teaching and complete a project, and New Zealand teachers report the advantages of 9 month study awards as providing a chance for reflection on their work.

If one takes the view that teacher development is and should be an ongoing activity then duration is not an issue—development will be a continuing part of a teacher's life. This, however, requires a shift in the culture of many schools.

Frequency

What should be the time between sessions? To allow for experimenting (when one trials ideas and colleagues interact supportively), there is a needs to have a significant period sandwiched between sessions. If the programme is part of a department's ongoing meetings, perhaps fortnightly sessions would provide adequate time. Each person and each institution has different characteristics and the time taken depends on these individual factors (Support for Innovation Project, 1989).

6.6 Resources

As previously mentioned (1.2, p.5), there is a Maori proverb "of all the things in the world, the most important is people, people, people". People are not only an important resource in professional development, their growth is the purpose for development. This importance is recognized in the literature. For example, Fullan (1982b, p 249) stressed that

> *the implementation process has frequently overlooked people (behaviours, beliefs, skills) in favour of things (e.g., regulations, materials) and this is essentially why it fails more times than not.*

A decade later, in an article on systemic change, he was still emphasizing the value of the individual (Fullan, 1993a).

People are one resource, the other major one is money. At present in New Zealand there are four sources of teacher development funding. The major one is the school's bulk operating grant which is controlled by principals and boards of trustees; the second is through colleges of education and advisory services; the third is through the Teachers' Refresher Course Committee; and the fourth is from the Ministry through teacher development contracts (Ministry of Education, 1991).

With the major source of funds being in school grants, each school must determine how much it will spend on professional development, and how it will be spent. This means that schools must face the issue of getting value for their money. One of the major costs is the cost of teacher-relief. In England teacher relief accounts for between 70 per cent and 95 per cent of the grant in all schools (Day, 1991). One solution suggested in England was that teacher development activity

> *should be built into the academic year timetable, so that teaching class disruption (that black cloud shrouding the silver lining of traditional off-site course-centred INSET) could be minimized* (Douglas, 1991, p.89).

This could mean that all the members of a mathematics department might have the same non-contact period every week so that they could meet, or that teacher-only-days would occur within the school year.

If one believes in devolution, in self-managing schools, and in teachers' professionalism, then there seems little reason for alternatives to the bulk grant option. It has been argued by Douglas (1991) in the United Kingdom, that, as far as possible, control of all teacher development resources should be in the hands of the schools and, within the schools, this control should be delegated to the teachers affected by development. This fits with the philosophy of autonomous teachers and schools since such control would contribute to ownership of development.

Unfortunately, a bulk operating grant sets schools up as targets for advertising by external providers of development. Such advertising may tempt school managers who want to appear to have done what they can to satisfy all the development needs of staff. Most schools look carefully at development and spread their limited resources as widely and wisely as possible but Bolam (1987, p.48), reporting on the situation in the United Kingdom, said that most schools aim for improved group and individual performance but that this

> *has two unintended and undesirable consequences: first, a severe reduction in teachers' opportunities for sustained professional development via longer courses; second, and especially ironic, the adoption of approaches (i.e. one-off short workshop-type courses) which our technical professional knowledge tells us are an ineffective way of improving teacher and school performance.*

6.7 Affective influences

Another variable in professional development is the role of feelings in learning and in the process of change. Concern has been expressed about the need to contend with the personal and anxiety-ridden learning process experienced by individuals working on change (Claxton and Carr, 1991; Fullan, 1986). The personal and social dimensions to professional development are important (see 6.4). Some of these have been identified by a number of authors (Bell B, 1993a; Leinwand, 1992; Fullan and Stiegelbauer, 1991; Judson, 1991; Nias, 1987; Deming, 1986, Elliott, 1977; Marris, 1974). They include:

- predisposed feelings about change and risk-taking both in general and in relation to a particular change
- feelings of personal insecurity, lack of confidence, and fear of failure
- fear of losing control while making a personal change (the more fundamental the shift, the deeper and more traumatic the uncertainty)
- cultural beliefs that might conflict with change
- behavioural norms that might conflict with change
- trust (or lack of trust) in management, unions, and/or colleagues
- historical events relevant to the change
- intensity of threat inherent in the change
- manner in which the change is introduced and implemented (insufficient time, lack of support)
- upsetting the status quo (the resource mix or the authority roles).

To help reduce the impact of these influences numerous authors (Bell, 1993a; Bocchino, 1993; Fullan and Miles, 1992; Guskey, 1986; Fullan, 1985a) have made suggestions which have been considered throughout the review. The suggestions are:

- participants need to understand the change process and be aware of the uncertainty, stress and anxiety that is likely to emerge
- support and assistance is crucial if the anxiety is to be coped with
- participants should initiate, plan and control the programme as this helps begin the development of ownership which builds up during learning
- ideas from all participants should be valued
- lessen dependency on outsiders
- identification of needs must be in the hands of participants and not linked to any teacher assessment plan
- people need to be helped to know that *who they are* is different from

what they can do

- feedback must address specific actions and not the person
- the personal concerns of teachers must be addressed in a direct and sensitive manner.

The personal dimension of change is linked with a person's self-image. This appears to be made up of three types of self-evaluation:

1 estimates of one's independence,
2 estimates of one's worth, and
3 estimates of one's specialized competencies or interests

(Mercer and Evans, 1991).

Where independence and control with regard to work are desired but not achieved, dissatisfaction builds up. In teaching, it could be argued that the professional role has been diluted by the requirements of national curriculum and assessment initiatives which have deskilled teachers in that decisions about curriculum content and assessment have been taken away from them. Whether this is the case is irrelevant, since what is important is the teacher's perception of the situation. Mercer and Evans (1991) suggest that there is a strong feeling in teaching that teachers do not have the status they once had in society. They also argue that dissatisfaction occurs when teachers' competencies and interests are ignored, and they are required to teach topics or subjects in which they have not been trained.

In terms of professional development these issues—estimates of one's independence, worth, and competencies and interests—need to be addressed. If they are not then teachers may feel they are not valued and may withdraw from participation in professional development. Addressing these issues may involve making them explicit, sharing the feelings with colleagues and discussing them in terms of societal changes. People's self-images are likely to change when they see that colleagues value them and this can be facilitated by putting people in roles in development activities where their competencies can be appreciated.

Resistance to change is another facet of the affective influences on professional development. In any project there is likely to be resistance. One cannot assume that this is out-right rejection of the values

embodied in the change, or hard-core resistance to all change (Fullan and Stiegelbauer, 1991). Resisting change may be irresponsible obstinacy but it may also be the responsible rejection of a project that is undesirable or is unlikely to succeed; in other words it may be the only way to maintain sanity and avoid complete cynicism (Fullan, 1989b). Resisting change may reflect a conservatism or a desire to retain the status quo, or it may reflect a lack of knowledge about the innovation (Dalin, 1978). It could also reflect important value or power conflicts, and give a number of 'signals' to reformers (Dalin, 1986). Such resistance is likely to emerge with an imposed project, not when participants have total control of their own development.

6.8 Some economic considerations: costs and effectiveness

With the restructuring of educational administration in New Zealand, school funding was adjusted so that more local responsibility would be taken for activities that had been centrally funded in the past. Supposedly, professional development was one of these activities. However, even while devolution was being implemented an inconsistency emerged. More control was assumed by the Ministry through curriculum initiatives with associated assessment, and through the funding of providers through contracts to supply specific teacher development. A confusing picture emerged. On the one hand devolution indicated an empowerment model where schools would take more control of teacher and curriculum development and through these activities, become more professional. On the other hand, control by the centre emphasized the continuance of a model with imposed initiatives.

A similar situation is discussed in the OECD report (1990, p.12) which claims that in

> *many OECD countries there is a growing demand for efficiency in the use and management of resources, especially public resources, as a condition of their expenditure. Once again, that demand may not always take forms that arguably are in the best interest of education, nor even of their most efficient use. Yet whether that demand is for more regular evaluations of schools and colleges and the work teachers do, or a greater willingness on the part of educational institutions to open their doors to the outside world, or the more formalized step of developing performance indicators, it is unlikely to be short-lived.*

The report goes on to emphasize the need for teacher control of developments. It says (p.12) that

> *the dangers of simplistic, distorting forms of evaluation and appraisal will be significantly reduced if teachers themselves are actively involved in their construction and implementation. Indeed, that is a precondition of their success.*

In the current 'partially' devolved climate in New Zealand, one conflict is that of ongoing in-school programmes versus discrete pre-packaged programmes from a commercially oriented professional development industry. In New Zealand this includes the advisory services which are under pressure to recover some costs. Little (1992, p.175) is concerned that these packaged programmes place a premium on the

> *simplification and standardization of content.*

and that this is

> *essentially in conflict with widely-acknowledged conceptions of adult learning.*

He is concerned that

> *most administrators responsible for approving staff development expenditures stated a predilection for 'well-packaged programmes'.*

Within this context of accountability, Fullan and Stiegelbauer (1991) have identified a trend towards superficial change. They are concerned that schools are likely to adopt new instructional processes that do not significantly change structure, or to adopt new wrinkles in administrative management, because such innovations help to satisfy the demands of the public without exacting heavy costs.

Costs

Whether the community can afford teacher development or whether they choose to ignore it is not the issue. The issue is how to best use existing resources. Before making these decisions costs need to be considered and Little (1992, p.173) has analyzed the investment costs of teachers' professional development:

1 current expenditure associated with formal development activities (leader time, teacher relief, travel, facilities and material, fees paid)
2 opportunity costs associated with reduced instructional time
3 present value of teachers' resulting salary increases
4 participants' investment of uncompensated time and expenses.

The first two of these are reduced when development activities are scheduled outside school time, situated within the school, and the facilitation is largely done by people within the department rather than by outsiders. The third of these can be ignored in the New Zealand context because no direct rewards accrue in the form of salary increments. In most countries the fourth of these is usually ignored by all but the participants. However, it may become more of a problem as development is increasingly scheduled during non-teaching time. Some provision is made in New Zealand for the claiming of expenses but there is no indication of any intention to go further. Whereas the first component is the only one that is a direct cost and therefore a budget matter, care is needed to ensure that indirect costs are acknowledged and borne equitably.

The low cost options are easy to identify, but cost alone is of little use. What is needed for planning is a cost-effectiveness figure which could be used to rank possible development activities during planning. Such a figure would be obtained by dividing the measure of effectiveness by the cost. To do this we need a measure of the effectiveness of various activities in improving student performance. This is difficult to ascertain as improvements in student performance are not easy to measure directly and accurately, and specific development activities are not the only factors influencing it. Improvements in student performance are normally expected because of teaching, but how much of it is due to a change in teaching is virtually impossible to measure.

Effectiveness

Little research seems to have been done to quantify effectiveness. When development is viewed as ongoing teacher-learning, the time for significant innovations to be implemented is considered to be two or three years. The rates of change for teachers varies considerably, and teachers and students are subjected to many influences. It is therefore virtually impossible to judge the long term effectiveness of development activities in terms of improvements in students' learning. While the measurement of change in teacher behaviour and practice is comparatively simple, with ongoing development activities or a number of small projects it may be difficult to say which activities caused which changes.

Potential effectiveness

An alternative is to consider the quality of the professional development model. This might be done by assigning a measure of potential effectiveness by checking how many of the components or aspects of development activities (from 5.2, p.45) are included in any proposed programme. These may be weighted differently in different situations. For example, the preparation and planning stages are very important when a school begins to take responsibility for professional development, but become less important once a tradition of delegated control and a culture of change is established.

Cost-effective

Under these circumstances, the best measure of cost effectiveness would be obtained by dividing the measure of potential effectiveness by the budgeted cost. A comparison of these measures for a range of activities would help planners in choosing activities.

The two ways of improving cost effectiveness are to improve effectiveness by ensuring that most of the components are included, and reduce the costs by minimizing the need for teacher-relief, travel, and external assistance. This suggests that well-designed, ongoing and regular professional development centred within a school or a department, timetabled after school or using other non-contact time, and using expertise from existing staff is likely to be the most cost effective.

6.9 Summary

In this chapter a number of variables affecting professional development that need to be considered by policy makers, school managers, and professional development planners, leaders and facilitators have been discussed. These are responsibility, leadership, providers, location, time, resources, affective influences, and some economic considerations.

In chapters 4 and 5 the consideration of the professional development process and possible formats for development programmes started to suggest the need for development to be based in schools and be controlled by the participants. The general conclusion from looking at the variables that influence development supports this view. The next chapter takes this further by considering what might need to be considered inside the school and during planning to ensure that school development is likely to be effective.

Chapter 7 IN-SCHOOL DEVELOPMENT

7.0 Contents

7.1	Introduction	84
7.2	Establishing a vision	84
7.3	Planning for in-school professional development	87
7.4	Needs appraisal	90
7.5	Role of the head of department	94
7.6	Regular meetings	95
7.7	Culture of the school	96
7.8	Assessment and evaluation	97
7.9	Summary and conclusions	100

7.1 Introduction

In chapter 4 the literature surveyed was concerned with the process of development. In chapter 5 the focus narrowed to the format of development and in chapter 6 even further, to some specific variables that influence development. In addressing the two main research questions, what are the professional development needs of high school mathematics teachers? and how might these needs best be met? the literature suggests that no simple solutions exist, but that professional development should be cooperative and ongoing. This implied that it should be based largely in schools. Ideally it will be controlled by the participants, address the diversity of issues that they see as important, and be based on constructivism which has emerged as the theory to explain learning accepted by most mathematics educators.

In this situation an ethos for continual development needs to be developed and this chapter is concerned with the details of in-school organization that must be addressed for such an ethos to be established and to flourish. Some of the issues may seem practical and mundane, but they are important if professional development is to be effective.

7.2 Establishing a vision

Establishing a vision is part of in-school professional development. Mission statements in the business sector reflect the need to have a sense of vision and purpose. In the same way schools and individuals need to have a sense of direction, in particular with respect to professional development. According to Staessens and Vandenberghe (1994) vision-building and vision-consensus play central roles in the

social construction of a professional culture. In their research they found that *high-vision* schools were characterized by a high degree of awareness of the common goals perceived by staff to be important. The teachers in these schools were used to talking about their schools rather than only about their individual tasks, there was evidence that actions and reflections were based on their common philosophy, and a greater feeling of collegiality existed.

Lieberman and Miller (1981) suggest that an established vision should allow for alternative approaches. They say that a vision must be adaptive because of the need to allow for change in the organization and in the change process. But most importantly they stress the need to have

> *a clear set of underlying principles and values about what needs changing in schools and how those changes should happen; a strong value base is the "system" that guides the seemingly ad hoc activities of change* (p.61).

If one uses the metaphor of a journey for teacher development then it can be asked what is most useful in planning - a map or an itinerary? The Arabic saying "to the traveller with no destination, one road is as good as another" clearly identifies the first need, a sense of direction. Whether one calls this sense of direction a vision, a mission statement, or development goals is immaterial but the direction needs to emerge from a group that is characterized by an atmosphere of trust and confidence; the goals are clearly understood and accepted because they have emerged from a group with a pattern of highly interactive interpersonal relationships; and the leadership within the group integrates the group effort by using the capacities of the individual members (Knowles, 1990). After the sense of direction, the next decision might be that

> *it is more important to have a map than an itinerary. A map provides conceptualizations of where one wants to go without looking at only one way to go there*
> (Lieberman and Miller, 1981, p.61).

Making a vision for professional development explicit has been referred to as the requirement for individual implementers to work out their own meaning (Fullan and Stiegelbauer, 1991). They suggested that conflict and disagreement are not only inevitable but fundamental to successful

change and this seems reasonable if people are working towards a new shared vision. They reasoned that the development of the vision is essential as it provides the criteria for overall planning and a screen for sifting valuable from not-so-valuable learning opportunities that inevitably arise during instruction. This vision needs to be established (Deming, 1986), articulated and shared (Louis and Miles, 1990), and periodically reviewed. It needs to be *thought of as a journey in which people's sense of purpose is identified, considered, and continuously shaped and reshaped* (Fullan and Miles, 1992, p.749).

There may be difficulties in coming to a consensus regarding a vision. Hargreaves (1994b) talks of vision and voice and distinguishes between the vision which is often a principal's and the unheard voices of the minority teachers. Even when a vote is used these voices may go unheard, and even when expressed, if they do not fit the values of others they will not be acted upon. The difficulty is to maintain the diversity of viewpoints, to ensure the vision is inclusive of all the voices and the values, and that a vote is not used in a way that contradicts or marginalizes the voices.

The questions arise, how specific should the policy on professional development be? and is a mission statement enough or is detailed policy needed? Some arguments for and against a written staff development policy were put forward by Hewton (1988). The reasons for a detailed policy were that it provides a focus, a form of organizational analysis, a direction finder, a coordinating mechanism, a form of commitment, an instrument of communication, and a framework for coping with change and managing the process. The reasons against were that:

i policy can exist without being formally stated,
ii a written policy may inhibit flexibility and prevent a rapid response to a new situation, particularly if all resources are committed,
iii to draw up a policy properly requires considerable time, particularly if all staff are to be involved in the exercise; and
iv implementing a staff development policy is costly and the cost may not be justifiable.

Any school or department needs to consider these reasons for and against when making a decision about a policy.

It should be pointed out that a vision need to be recognized as a necessary but not sufficient condition for influencing others to change; as Fullan (1989b) indicated, the other thing that is needed is an understanding of the process of change (4.4, p.37).

7.3 Planning for in-school professional development

While establishing a vision is one part of planning there are other aspects that need consideration. Planning for the RDD or the problem-solving model suggested a pre-planned and sequenced plan of action. With models such as the evolutionary planning model, planning is more general. One still needs to consider some implications in terms of focus, size and scope, and getting started.

Choosing a focus is a part of planning and in considering focus a typical first reaction is that if development is concerned with implementing single, well-developed, proven innovations one at a time and there is time to do this, then it will be easy. In fact schools are under pressure to implement a bewildering array of content, teaching approaches and assessment projects, and other innovations and policies simultaneously. At the same time teachers are encouraged and expected to be reflective, sort out what is problematic in their own classes, and do something about that too. The complexity of the change process is made worse, according to Fullan (1989a), by the fact that too many projects are launched, implementation is often attempted too early (i.e. the political process often outstrips the educational development process), overly ambitious projects are adopted, and simultaneous multiple projects are introduced in an uncoordinated way.

An important decision about development is to do with its focus. In 4.5 (p.40) the school, the individual, and mathematics were seen as foci but the more fundamental issues about learning theory and the process of change underpin these. The choice of initial focus must be up to the participants, and they will get to the more fundamental issues when they are ready to. There will of course be external pressure to implement specific innovations. One way to interpret this pressure has been suggested by Fullan, Bennett and Rolheiser-Bennett (1990, p.19) which ties in with the teacher growth view. They suggest that

> *innovations should be used as points of departure or catalysts, rather than as things to be implemented*

and add that

> *fixing on particular innovations is less important than paying attention to the potential ways in which classrooms and schools can improve.*

This fits a postmodern situation with no grand theory about professional development, yet offers a way through the ambiguity of the multiplicity of influences, each pulling in its own direction.

Sometimes the decision is made to keep the focus on what will benefit the school, but an astute principal will also help members of staff to enhance their professional prospects. The 'loss' of good members of staff is usually more than balanced by the lift to morale and the sense of ambition that the promotion of a member carries with it and the benefits of development need to be seen as benefits to the profession as a whole.

Another aspect of planning is to consider the size and scope of development. This leads one to the question of whether it is better to attempt small changes or should the focus be on major change? Berman and McLaughlin (1977) found that ambitious projects were less successful in absolute terms of the percent of the project goals achieved, but they typically stimulated more teacher change than projects attempting less. When the scope or magnitude of a proposed change is significant, provided that people are able to start with parts of the change and build incrementally in a developmental way, then the size should not be a deterrent (Fullan, 1986 and 1989b). This fits with evolutionary planning, with Deming's (1986) idea that many aspects of any system are interrelated, and with what has become known as 'systems thinking' which is a recognition that change is systemic (affects the system as a whole) (Bocchino, 1993; Senge, 1990).

The two main aspects to working systemically, are (Fullan and Miles, 1992, p.751):

- *reform must focus on the development and interrelationships of all the main components of the system simultaneously - curriculum, teaching and teacher development, community, student support systems, and so on; and*
- *reform must focus not just on structure, policy, and regulations but on deeper issues of the culture of the system.*

The other questions about size and scope are, as Fullan (1986, p.82) asked,

> *does one start with a small or large number of people? should one start with volunteers or include all those affected? should one undertake the exercise demanding large-scale changes or more modest ones?*

From a teacher growth perspective, ideally one involves all teachers, but it is natural to start with a smaller number because of the voluntary nature of adult education. Fullan(1986, p.83) suggests that there are no clear answers to these dilemmas and that

> *the number of participants should be small enough to be manageable, but sufficient in size to be conducive to sustained interaction among those implementing change.*

A further aspect of planning is getting started. This is not a linear process starting with vision. Cervero (1992, p.92) suggested that

> *the goal of professional practice is wise action* and that *knowledge acquired from practice is necessary to achieve this goal.*

He suggested a model of learning from practice which would continually include reviewing practice and goals. Richardson (1990) echoed this when she said that practical knowledge allows a teacher to quickly judge a situation or context and take action on the basis of knowledge gained from similar situations in the past. Reflecting on the action and its results adds to the teacher's practical knowledge (Schön, 1983 and 1987). These ideas reflect the premises on which the evolutionary planning model of Louis and Miles (1990) is based.

The initial formal stage of getting started is the establishment of the vision. It may be influenced by needs appraisal (see 7.4, p.90), with the recognition of the need to change caused by problems, by pressures from external sources, or from a quest for quality and improvement.

Planning a programme

The four criteria suggested by Posner, Strike, Hewson and Gertzog (1982) in relation to the learning process seem useful when planning a development programme—dissatisfaction, intelligibility, plausibility and fruitfulness are the four. More specific recommendations from Baskett, Marsick and Cervero (1992) include working toward a holistic approach to improve professional learning, paying greater attention to practical knowledge, moving to where the learning occurs, and creating

systems for 'just-in-time' learning. Just-in-time learning is similar to the just-in-time approaches Deming (1986) suggested for industry. It implies that development needs to be constantly available and the timing of sessions needs to be linked closely with the work of the teacher.

In terms of planning it is desirable to know what sort of activities are more effective than others. Åke Dalin (1987) assumes that development will occur in schools. From her research she listed a hierarchy of activities in order of effectiveness that need to be considered at the planning stage.

1 starting with a challenging task
2 interaction with colleagues
3 personal reading (also supervision and feedback)
4 job-rotation
5 work-specific courses
6 general courses.

Planning also needs to acknowledge that opposition may arise. Taylor (1981), working with rational models for development, stressed the importance of determining the driving and restraining forces, then mobilizing the driving forces and deterring the restraining ones. He suggested that one way to overcome potential opposition was to involve the potential opponents in the plan for change. This contrasts with the view taken with evolutionary planning— start small, experiment, find some advantages, then share these.

7.4 Needs appraisal

Needs appraisal can be a part of in-school development whether one is considering teacher learning, school improvement, or subject (mathematics) development. Bolam (1987) suggests that the identification of individual needs will be by a staff appraisal schemes but institutional (department or school) needs arise during the formulation of development plans.

From the ideas of Mortimore and Mortimore (1991), NZPPTA (1991), Blake and Jacques (1990), Drucker (1990), OECD (1990), DES (1989 and 1985), Lowe (1989), Mathias and Jones (1989), Day (1988), table 7a has been constructed to summarize some common purposes, methods, foci and dangers in typical staff appraisal schemes.

Table 7a Some purposes, methods, foci and dangers with staff appraisal

Purpose	report on teacher effectiveness inform teacher of current performance provide feedback and recognition; plan for professional development encourage the acquisition of new skills develop a career plan and aid promotion planning help poor teachers improve dismiss incompetent teachers
Methods	classroom observation (possibly research based) (negotiated not imposed) self-review questionnaires conference/interview (possibly pre and post) formal annual review meeting
Focus	strengths job description job satisfaction job dissatisfaction difficulties which prevented intended achievements assisting improvement , with help from: the school organization the principal the head of department anyone else main target(s)/goals for next year? career planning
Dangers	bureaucratic impersonal superficial inequitable lack of learning outcomes

Establishing the purpose for an appraisal of needs is important. An issue that arises regarding the purposes is that the usual rhetoric for personal and school appraisals is that they will help target professional development needs more effectively. In an economic situation when resources for education are shrinking, many teachers view this rather cynically (Blake and Jacques, 1990). They are concerned that the information might be used in employment contracts negotiations or when schools are dis-establishing positions. As Edwards (1992) puts it, appraisal can be summative or formative, that is for firing or fixing. To overcome these fears, care is needed to ensure that a review must lead to action, and to sustained action.

While needs appraisal might be seen as a formal or informal process, the purposes listed in the table would, with the reservations already

mentioned, be generally accepted. There is one notable omission from the list and that is student learning. The listed methods reflect those currently in practice. The possible foci listed fit reasonably with a model based on building on strengths rather than making up for deficits, although this depends to a large extent on the appraisers and how they interpret a focus. The dangers, or fears, are aspects that often deter teachers from embracing needs appraisal programmes. They fear that it will be a formal process with no benefits, they see the process as paying lip-service to development, and knowing that development is often a matching of courses and people, they see the process as not being relevant to their situation.

If schools develop their own policies and guidelines to control appraisal as part of a well-defined professional development policy, then some of these dangers might be perceived as less valid. An aim in such a policy statement might be to assess the individual in relation to the whole organization and therefore to link the appraisal procedure and the development needs it identifies (Mathias and Jones, 1989).

One question that always emerges with appraisal is who does the appraising? Teacher appraisal is usually done by the teacher's immediate supervisor, by a peer (usually chosen by the appraisee), or by a process of self appraisal. If appraisal is to be carried out then it needs to be acknowledged that appraisers require a number of broad interpersonal skills—in which many principals and heads of department have not yet had training. McMahon (1981) sees a need for such training and Robertson (1992) is concerned that gender-related aspects should not be ignored.

An alternative approach would be to view appraisal as largely self-appraisal. The Scottish Education Department (1989, p.30) emphasized the responsibility of the individual teacher for development, but was sceptical about the adequacy of self-appraisal alone. They said that

> *an arrangement which relies entirely or predominantly on self-appraisal is unlikely to be effective, however; it requires to be complemented by professional dialogue in which a teacher's perception of his or her own work and needs is set against that of senior colleagues, especially the head teacher.*

Another alternative to establishing a needs appraisal scheme is to decide to have no appraisal. Deming (1986) advocates that the discussion of needs be done in small quality circles where the focus is on changing the system, not people. He is categorical in his demand that formal appraisal systems need to be removed, and claims that they nourish short-term performance, stress rivalry and demolish teamwork. Building on Deming's ideas, Holt (1993, p.383) says that

trust is a better motivator than fear

so staff appraisal and merit pay systems must be rejected,

cooperation is much more important to quality than competition.

Each school needs to decide whether a needs analysis system is needed or desirable, or if an alternative exists. If it is wanted, then it requires more than the systematic collection of information. It involves astute leadership, careful negotiation and an attempt to achieve consensus and commitment in situations where the views and interests of different individuals or groups may not coincide (Hewton, 1988). It should precede the drawing up of a staff development policy and form a continuing part of policy implementation and revision. Appraisal is not development; it is one small aspect that contributes to it. Like development, it is not done and then finished; it is ongoing (Mortimore and Mortimore, 1991). It involves reflection, self-confrontation, a lessening of isolation, team building, and should contribute to a sense of achievement, appreciation and ownership (Day, 1988).

As well as personal appraisal systems to establish individual needs, Bradley (1991) talks of school self-review to establish school needs. A further dimension that is possible is a department review to establish mathematics education needs. This could be considered as implied as either part of a whole school review or as something that emerges from the appraisals of individual mathematics teachers. One way of doing school or subject reviews is to use teachers-as-researchers (action-research) and use their skills as reflective-practitioners.

A successful school or department review, which is to appraise the needs of the system rather than the teachers, has a number of characteristics (Bradley, 1991; Huberman and Miles, 1984):

- the staff of the school or department are the main participants and have ownership of the process;

- the review process links with all forms of development;
- the review process is part of a continuing (and cyclical) process;
- those concerned move forward by negotiation and agreement;
- a number of planning elements are evident;
- the review asks where the school (or department) stands now, how well it is performing, where it wants to go in the future, and how people feel about the future direction;
- staff have ownership of the process;
- data gathered is for the information of the staff only;
- decisions on what to do as a result rests with the staff;
- the whole staff is involved;
- the purpose is primarily developmental.

It is possible that if a good development programme is implemented then this type of review will develop naturally.

7.5 Role of the head of department

Another important influence on in-school development is the role of the head of department. Four principles from Deming (1986) apply to schools and heads of department in terms of development:

ii management is leadership rather than supervision

iii leaders must know the work of their team

iv development coordinators need to be appointed in schools

v the expertise of heads of department needs to be developed so that they can provide professional development leadership.

Most schools would implicitly agree with these principles, but in terms of providing professional development something is lacking. Hannay and Denby (1993) collected data in Canada from 35 department heads, representing all disciplines, sizes of department, and 15 secondary schools. They concluded that although the department head may be in a position to facilitate change, there is little evidence to suggest that in reality they carry out this role. While they invest a great deal of time in the role of the department head, their lack of understanding in facilitating curricular change is making their task more difficult. Their findings suggest that department heads need assistance in learning to manage change and in understanding the nature of change.

One way of achieving this, suggested by Hannay and Denby, is to restructure school and/or departmental organization to better meet this

proposed challenge. They suggest that a move away from a subject-area organization to one that represents the trend towards subject integration should be considered, and they say that departments must at least

> *begin to develop ways to deal collaboratively with integrating subjects, developing alternative teaching strategies, and embedding professional development into the fabric of the school* (p.25).

7.6 Regular meetings

Regular department meetings are an aspect of development that is closely linked with the role of the head of department. A typical department meeting might serve five purposes: administrative, social, personal, support and professional. To ensure that a professional development purpose is achieved at meetings, the head of department (or assistant) needs facilitative skills. If such skills are missing then provision should be made to help the person learn them. Regular professional development meetings may not be whole department meetings. They could be more like quality circles—small informal teams of people rather than formal staff organizations. These would determine their own priorities and the time for their meetings (Deming, 1986). They would be concerned with bringing about an improvement and would offer critical reflection in a formal but non-threatening setting to establish priorities for development (Holt, 1993).

Another way of looking at meetings is by comparing the old approach to management based on organizing for stability where the central concern was efficiency, with the newer one based on organizing for change with effectiveness as the main concern. This new approach requires:

i vision (both articulated and shared);
ii guidance based on judgements rather than rules;
iii a basis of accountability;
iv a focus on team building;
v strong networks with an emphasis on autonomy;
vi multi specialisation (organizational flexibility); and
vii a concern with the 'whole' person (Louis and Miles, 1990).

Ensuring that the focus is effectiveness requires a skilled facilitator.

7.7 Culture of the school

Another aspect of the school (or the department) that influences professional development is its culture. Some of the attributes of such a culture have been identified by numerous authors (Guskey and Sparks, 1991; Erickson and MacKinnon, 1990; Fullan, 1988a; McLaughlin and Pfeifer, 1988; Baird and Mitchell, 1986). These attributes include: a willingness to change, trust, open communication, commitment to organizational aims, and commitment to individual learning. Deming (1986) adds the idea that teachers need decision-making autonomy (and suggests that perhaps they should have a personal budget for their annual classroom and professional development expenses).

The culture influences the success of development activities and this success is linked with the aim of changing the culture of institutions, rather than implementing single innovations (Fullan and Stiegelbauer, 1991). A school culture needs to provide an atmosphere in which professional growth is encouraged (McMullen, 1991) and where professional development activities are parts of a long-term process—a *culture of continual learning* (Capper, 1992), not a series of discrete unrelated events. Fullan (1989a) implies a culture of practicality, sharing, planning and development that involves all staff when he talks of successful innovations that:

i become embedded into everyday practice,
ii are in widespread use across several classrooms and schools,
iii are not contending with conflicting priorities, and
iv are subject to continuing in-service.

Another aspect of culture is inclusiveness. Capper (1992) argues that the aim is to

> *establish a learning organization that incorporates learning for all staff, role rotation and redefinition, participatory decision systems, multi disciplinary and multifunctional teams, open information systems, and a secure staff.*

At the individual level Clarke (1991, p.14) cites the Rand studies finding (McLaughlin, 1991; McLaughlin and Marsh, 1978) about the importance of the teachers believing that *the teacher can help even the most difficult or unmotivated student.* This reflects a culture that values all the people within a classroom. Such a culture is also likely to value all the staff and see professional development as being for all.

7.8 Assessment and evaluation

Five aspects of assessment that need to be considered in terms of professional development are:

i diagnostic assessment (before development),
ii formative assessment (during development),
iii summative assessment (after development),
iv self-assessment, and
v external review.

The need for assessment and evaluation is partly for educational reasons but also to satisfy the political pressures for accountability.

Diagnostic assessment

In the context of professional development diagnostic assessment is done as a needs appraisal exercise, as part of the establishment of a development plan, or as part of evolutionary planning. When carrying out this assessment the purpose needs to be clear so that participants know that what they perceive their needs to be rather than their deficits are being identified. This should ensure that resulting development focuses on their growth as teachers rather than on imposed change.

Formative assessment

Formative assessment in professional development is concerned with monitoring the development process. It may be built into the learning process as reflection (see 4.3, p.36), or as monitoring.

Handel (1990) suggests three hierarchical levels for reflection:

i reflection on actions at the lowest level.
ii reflection on practical and theoretical reasons at the central level,
iii reflection on ethical justification at the highest level,

He believes that teachers in Norway rarely move beyond the first level and suggests that this might be due to the 'busyness' culture of schools. The pattern seems similar to the pattern in New Zealand, not only with reflection, but also with action research and other teacher development activities. Teachers are concerned first and foremost with their actions, that is, with what they should do.

In a participant controlled programme it is comparatively easy to get 'off task' but, according to Tafel and Bertani (1992, p.45)

> *careful monitoring and benchmarking of significant changes can keep change efforts on track . Monitoring changes in skills,*

attitudes, knowledge, involvements, relationships and capacities can validate any change that is occurring. Benchmarking can provide much needed encouragement as the change effort proceeds.

Summative assessment

Summative assessment serves little use in professional development. Managers such as Deming suggest it has no use at all because one generates quality by building it into a system rather than by inspecting for defects at the end (Holt, 1993). Another reason for rejecting summative assessment is because of the difficulties in measuring effectiveness. These were highlighted in 6.8 (p.82) and included the extended time for development, the ongoing nature of development, and the multiplicity of foci and activities for development.

When a development activity is run as a course it may seem reasonable to ask the teachers who took part

> *whether they thought the experience was interesting, well arranged and likely to be influential in their work. Of course, a disturbing and uncomfortable experience can sometimes be a source of considerable learning and that needs to be kept in mind when interpreting what teachers say. But positive learning from a negative experience is likely to be the exception rather than the rule* (Thomas, 1991, p.131).

But Thomas goes on to suggest that reporting to organizers at the end of a course, or to staff on return to school only produces short-term responses which do not allow time for trying out ideas with children.

Although better learning by students is the aim of professional development activities, it is not easy to measure, nor are the reasons for improvement easy to assign. Standards, like examination results, can be improved at the expense of a broad education which balances content and processes in a way that it is not easy to measure. As Thomas (1991) pointed out, changes in what students do and learn at school are intimately but not always simply related to changes of teaching practices, and these alterations in what they do are easier to identify than are changes in how well they learn.

Self assessment

If one is looking for long-term and specific change that participants have chosen and worked on, then the areas of interest are likely to be:

i change in participants,

ii change in the organization, and

iii change in students.

While these can be assessed by tests, interviews, observation and self-assessment (Guskey and Sparks 1991), if the participants made the choice of area to work on then self-assessment is probably the most appropriate method. It is also comparatively cheap and is non-threatening for those involved. Indeed it is almost impossible to imagine teachers taking part in a development programmes without asking questions about whether what is being done suits their needs and the needs of their students, and whether there is a reasonable prospect of putting what is being learnt into practice in the classroom (Thomas, 1991).

According to Rogers (1969, p.142)

> *The evaluation of one's own learning is one of the major means by which self-initiated learning becomes also responsible learning.*

While this claim was made in the context of student-learning, it is equally valid in professional development as each individual teacher has to take responsibility for deciding what criteria are important, what goals to aim for, and the extent to which those goals are achieved.

Biddulph, Carr and Bell (1989, p.5) say that

> *if assessment is to promote better learning then the major focus must be on helping students develop strategies to identify what they are actually learning from the experiences they encounter. In other words the emphasis must be on empowering learners to become their own personal learning auditors.*

Reinterpreting this into the context of a development programme, there may be a need to help participants to:

i recognize criteria that point to development,

ii construct and use strategies for reflection,

iii compare their self-assessment with that of others, and

iv compare their present knowledge with that of others so that they can appreciate the other views that are possible.

External evaluation

An external evaluation is seen by some as a desirable approach to evaluation of professional development. Douglas (1991, pp.93–94) claims that it has important benefits. In his words,

> *both participants and non-participants are made aware that their activities are valued enough to be studied seriously, and the final report, published a year later, did help validate the process (which is not to say it found nothing but success) both for us as insiders, with future intentions for school-based activity, and also for outsiders whom we needed, and need, to convince. Finally, the process of evaluation employed, which was for the evaluator to get inside the project as it progressed, by listening, interviewing and helping us reflect, was helpful, as was the final report. We were perhaps fortunate in having the right kind of evaluator.*

7.9 Summary and conclusions

This chapter was based on the assumption that in-school development was likely to be the most important aspect of professional development. Accordingly the aspects that impinge on in-school development were considered, these were the establishment of a vision, the planning process, needs appraisal, the role of the head of department, meetings, school culture, and assessment and evaluation.

This final chapter of the literature review is based on successive refinement from the broad consideration of the professional development process, to a consideration of the format of development and the essential components of successful programmes, to the specific variables that influence development, to the in-school factors.

At this stage the conclusions reached from the four chapters of the literature review are that professional development:

i is an ongoing change process which can be based on a constructivist theory of learning that needs to be well understood by participants;

ii is based on teachers learning rather than imposed change, and accordingly builds on strengths rather than focuses on deficits;

iii has three main interrelated phases,
- planning,
- taking and making initiatives, and

- empowerment;

iv needs to take into account the personal and social dimensions as well as the professional;

v needs to attend to a broad range of foci including aspects to do with the school, mathematics, and the teacher;

vi must include a range of components that generally require considerable time;

vii should be based mainly in schools and controlled by the participants; and

viii needs leadership from the heads of department who are likely to require help to develop appropriate leadership skills.

In the following chapters these ideas about professional development are explored further and the overseas situation compared with that in New Zealand.

PART C **SOME VIEWS ABOUT PROFESSIONAL DEVELOPMENT**

Chapter 8 Teachers' views 103

Chapter 9 Mathematics educators' views 129

Chapter 10 Views from policy documents 138

Chapter 11 A synthesis of views 160

This study stemmed from the researcher's concerns about professional development. The initial aim was to consider the professional development needs of high school mathematics teachers and how these might best be met. A further aim that emerged from this exploration was to identify some principles to help plan professional development. In this part of the study the aim is to find the perceived needs of the teachers and how to meet them. Three sources of data were used—mathematics teachers, mathematics educators and mathematics policy documents. These reflect different parts of the school mathematics community.

The teachers' views, reported in chapter 8, were based on their reflections on their experiences of professional development during their careers, largely limited to the New Zealand context.

Mathematics educators in New Zealand started as teachers, but as their roles changed they have focused more on the subject, visited many classrooms, and developed an overview of the profession as well as considered the individual teachers. Their opinions were expected to reflect this different perspective and are reported in chapter 9.

Numerous education policy documents with either a general or a mathematics-specific focus mention professional development. Some of the document writers were mathematics teachers and educators. Their perceptions about professional development are outlined in chapter 10.

The last chapter in this part (chapter 11) synthesizes this variety of viewpoints on professional development.

Chapter 8 TEACHERS' VIEWS

8.0 Contents

8.1	Research methodology	103
8.2	Analysis of data	106
8.3	Professional development requirements	107
8.4	Preferred types of development activities	113
8.5	Influencing factors	120
8.6	Some comments and conclusions	126

8.1 Research methodology

Sample

Interviews with a range of mathematics teachers from different types of schools were carried out to find their views about professional development. The teachers were chosen from six schools which, with respect to size and location, provide a cross-section of coeducational schools in the Waikato - Bay of Plenty region. Some details about them are in table 8a.

Table 8a Details of the six schools from which teachers were interviewed.

No	Size	Details about the location
I	Large	University city with a strong mathematics teachers association
II	Small	Remote rural district, 85 km from provincial city
III	Medium	Small town, 20 km from university city
IV	Medium	Provincial town, 60 km from university city
V	Small	Rural district, 45 km from provincial city
VI	Large	Provincial city, no university, but a strong mathematics teachers association

Time and timing

The interviews were carried out between February and August in 1990. At the time of the interviews schools were adjusting to their new administrative responsibilities (Peters, Marshall, Massey, 1994) caused by the changes resulting from Tomorrow's Schools (New Zealand Department of Education, 1988d).

Interview sample

Forty-six teachers in the six schools were interviewed. Ten of these were other than mathematics teachers—four principals (two with responsibility for professional development), one acting principal, one associate principal, and four professional development coordinators. The other 36 included six heads of mathematics department (HODs),

four other holders of positions of responsibility (PRs, i.e. assistant heads of department), two deputy principals who teach mathematics, and 24 assistant teachers. Interviews were numbered in order and these numbers are used to reference quotations. (T 7 refers to the seventh teacher interviewed, i.e. the acting principal of school V).

Table 8b Status and interview numbers of the 46 interviewed teachers.

School / Position	I	II	III	IV	V	VI
Principal or (Ass/Act)		5	3	25		20
Associate/Acting Principal	1				7	
Prof Dev Coordinator	43	(5)	30	(25)	8	17
Mathematics Staff:						
Head of Dept & PRs	2,38	45	4,33	10	9,6	16,19
Assistant teachers						
- Deputy. Principal	-	-	-	28	-	15
- Bilingual Unit	34	-	31	-	-	24
- New teachers (List A)	-	46	-	-	-	-
- Part-time	-	-	32	11,13	-	-
- All others	35,36 37,39 40,41 42,44	-	-	12,26 27	-	14,18 21,22 23,29

The thirty-six teachers represented all the mathematics teachers in the six schools except for two mathematics teachers (at the provincial city school) who preferred not to be interviewed. Part-timers teaching less than half a full-time mathematics load were not interviewed. Nearly half the interviewees were in senior positions. This group had had more experience with professional development and provided most of the data in the interviews.

The pre-service training of the 36 mathematics teachers is outlined in table 8c. While 47% of the teachers had secondary mathematics training, the percentage in individual schools varied from 27% to 86%. This range of backgrounds goes some way to explaining the range of perceived needs for development that the interviewees identified.

Table 8c Pre-service training of mathematics teachers

Type of training \ School	I	II	III	IV	V	VI	Total
Primary	5	-	1	1	1	2	10
Secondary but non-mathematics	3	1	1	-	-	2	7
Secondary, maths (University & T Coll)	3	1	2	5	1	5	17
Secondary, maths (Uni only, no T Coll)	-	-	-	1	-	1	2
Total	11	2	4	7	2	10	36

Interviews

Each interview began with an introduction explaining the purpose of the research, the procedures being used, confidentiality, and the topic. The teachers were asked to outline their careers to date, to describe the aspects of their work that had changed, and what caused, helped, or impeded them in making the changes. They were then asked to look at expected professional development needs in the next five to ten years and to consider whether their needs fitted with those of their department. The final questions were about how they would like their needs met and what support they thought was required. Supplementary questions were used to probe for more information and for clarification when the teacher was not forthcoming or the researcher felt uncertain about a response. The interviews were varied slightly for principals and professional development coordinators and were extended for heads of department so that more could be found out about the department and the school. The interview schedules (appendix A, p.221) were not adhered to strictly but used as a checklist to ensure that all the teachers had had an opportunity to comment on each topic.

The interviews varied from 20 to 50 minutes. They were audio-taped, transcribed (two to eight pages), checked for accuracy and returned to the interviewees for checking and comment. They were then read and relevant points highlighted. The framework for analysis of the data developed as the relevant points were clustered into categories and as the teachers' own words were considered. All the teachers contributed but the more senior teachers, with more experience of professional development and more concerns about the school, had more to say; their quotes are used more often.

8.2 Analysis of Data

The original intention had been to write six case studies to analyze the similarities and the differences between schools. So much common ground was found that it was decided it would be more appropriate to write a single summary of the data. Another factor that influenced this decision was that the teachers' breadth of experience often came from teaching in several schools rather than just the school where they were interviewed.

Research findings

The interviews were structured to explore teachers' experience and views of:

i professional development requirements,

ii preferred types of development activities, and

iii factors that aid or impede professional development.

Initial consideration of the data suggested the framework outlined in table 8d which was used for detailed analysis of data. The remainder of this chapter will amplify this framework.

Table 8d Categories of teacher responses.

8.3 Professional development requirements - school needs (planning, policy, priorities, school effectiveness, management, individual differences, gender equity, and bilingual equity) - people needs (induction, personal growth, career planning) - curriculum needs(teaching methods and mathematical processes, content, bilingual needs, and technology)
8.4 Types of development activities - in-school (meetings, sharing, teacher-only days, expertise, action research, observation, mentors, advisers, resources) - between schools (meetings and courses, examination marking, others) - individually initiated (reflection, courses and meetings, study, life experiences)
8.5 Influencing factors - time - resources - feelings and support - others

8.3 Professional development requirements

Teachers' responses on the content of professional development showed concern for their schools, colleagues, themselves, and curriculum area.

SCHOOL NEEDS

Assistance with planning, policy writing and priorities as well as school effectiveness, management, coping with individual differences and with equity concerns were identified as school needs.

planning, policy and priorities

All the principals and professional development coordinators were concerned about planning, policy, and priorities. With the advent of *Tomorrow's Schools* (New Zealand Department of Education, 1988d), they had been involved in the new task of writing school charters. For some this meant that they were also formulating policy on a number of topics including professional development for the first time. This had highlighted aspects of professional development to do with aims and objectives, structures within schools (administrative and guidance), responsibility for various activities, the Treaty, community consultation, policies on equal employment opportunities, and general school development.

school effectiveness

A second perceived professional development need was related to school effectiveness. This was a concern of twelve of the forty-six interviewees. They raised questions about effective teaching, maintaining standards, and monitoring of effective teaching. The value of courses to assist staff in this respect was highlighted by one principal (T 7)

> *The teacher/learning effectiveness courses that some of our staff have been to have been particularly valuable.*

management

Seven interviewees mentioned management concerns at department level, while accountability, leadership styles, roles for assistants with positions of responsibility, running meetings, sharing decision making, policy writing, and financial management were all raised as areas of need.

individual differences

Concerns were expressed by seventeen interviewees from all levels of the profession about help for teachers in coping with mixed ability classes and groups with special needs—the gifted, underachievers,

slow learners, students needing remedial help, and students with English as a second language. One teacher of slow learners (T 44) summed up one aspect of this concern,

> *... they were all a bit scared of dealing with the slow learners. I am sorry but that is real, that is a pretty harsh way for me to look at it but I tend to look at it - if you can, you can, if you can't, you can't and if they can't they stay away. And it is a sad indictment because those kids get a good deal if they have got someone that cares for them but otherwise, no.*

gender equity

Another perceived professional development need at school level was strategies to achieve gender equity. Nine responses were concerned with this, a typical comment (T 16) being,

> *... and the visit of the EQUALS people. I was lucky, I went up for that first two day seminar when those two people came and they really enlightened me because I had always felt a bit of a misfit. Even at 'varsity I got a lot of messages that maths wasn't the thing for girls to do and from my family as well. I couldn't fit myself and my personality with the images I have of what a good mathematician is and yet I loved maths and when those two people spoke to me and put me through those activities I realized a hell of a lot of things about maths and also about a lot of things they were saying were things I had always felt about maths in the classroom and the way girls liked to do their maths. So they brought a lot of things together for me and affirmed a lot of the thinking I had had.*

bilingual equity

Twelve responses concerning inequities to do with Maori were received. Bilingual mathematics resources and support was the most desperate need expressed by the small group involved in bilingual education. As one teacher (T 34) said, we

> *need* [the] *maths bilingual network to be strengthened at regional and national levels to feed off each other - initial need is to look at syllabus to assist both bilingual and maths people.*

PEOPLE NEEDS

Induction for new teachers, personal growth and career planning were categorized as people needs because they were directly related to personal needs and changing people rather than changing the school.

induction

Induction was seen as important, induction programmes and/or buddy systems for new teachers being taken for granted by all the interviewees. Most of the younger teachers had had good experiences with List A induction and the general feeling was that this should not be lost. One third-year teacher (T 26) said,

> *The first year I was here X ran it and his door was always open if you ever had any problems ... and you had the HODs and there was always someone there if you ran into a problem.*

and when asked about structured courses, continued

> *The only structured course I went through, in a sense, was the second, last year when Y had it and we got these little books and we had meetings every week.*

Five people expressed the need to extend induction to experienced teachers starting at a new school and teachers on promotion (even in the same school). Such support was seen to require more than a handbook, however useful, and should include social support, support for part-timers and relievers, and in particular, support for teachers who were not fully qualified. One teacher (T 40) reported,

> *I received a hand book. They have a session fortnightly that I can go along to at lunch times to find out about their audio visual set up, how the library is run, computer room; I can go to that every fortnight. That would probably be about it. I am not quite sure, I think a lot of these jobs you do, you tend to have to be in and find out.*

personal growth

Another people need identified was personal growth which was seen as an area for development by sixteen of the forty-six teachers—this included development in such areas as people skills, group skills, assertiveness, communication, conflict resolution, and coping skills. One teacher (T 41) commented,

> *T) ... I learned really good group skills there, not just the formal teaching but good group building skills.*
>
> *I) And assertiveness training?*
>
> *T) Yes, that helped. And it also helped my confidence because I was actually quite shattered after teaching in England. I thought I would never go back to teaching again because obviously I am not suited to it. And that helped build my confidence up to try teaching again.*

career planning

Nearly half the teachers felt the need for assistance with career planning. Probing by the researcher rather than volunteered responses revealed that many were not aware of the in-school options such as promotion in the areas of guidance, administration and curriculum. Nor had they considered other options in the education services such as teacher education, review teams, or educational administration. They suggested that professional development activities should be available to prepare teachers for career moves as well as being available after new positions were taken up. Two teachers (T 9 and T 30) commented,

> *... yes, I went for a week to a course that was run in Auckland half way through last year. It was excellent; in fact I really would like more of that because I knew nothing of being an HOD until then and I learned a lot and I could see that there was a lot more to do.* (T 9)

> *... we will be looking at things like the actual personal professional development in so far as looking at promotion. What do you actually have to do and put it in a CV? What is the best path to follow to where you want to go. If you want to be associate principal are you best to go as the HOD or as the Dean or a combination of both or exactly what is the story? Those are the sort of things that you only pick up if you are lucky enough to have a friend who knows. A lot of people go along in ignorance for five years, seven, ten years before they realize. I have helped a girl get a PR at ... and she had no idea what she had to put in her application.* (T 30)

CURRICULUM NEEDS

Curriculum needs are the needs that relate to the subject mathematics and the teaching of it. These needs include aspects of teaching methods, processes, content, and resources. Traditionally they have been the focus for most professional development. Teachers identified these areas as being of particular concern with teaching methods and processes being the main areas where teachers felt in need of help.

teaching methods

Teaching methodology was an issue with thirty-four of the forty-six interviewees. They sought more child-centred and student empowering strategies, help with group work and catering for individuals, more activity-based ideas, and more relevance in their work. Strategies for

ensuring enjoyment and motivating students were also often mentioned as needs. Issues of classroom management, lesson planning, thematic and cross-curriculum teaching were raised by teachers, with the overall view that many of the attitudes and behaviours of both students and teachers need to be changed. This is illustrated by the comments of two teachers (T 6 and T 28),

> *... the biggest change in my maths teaching career has been a change to more activity-based learning—that is not to say that all my teaching is activity based but more and more use of activities is being made in my maths classrooms ...* (T 6)

> *I would like to see us moving much more to an integrated approach to teaching. Maths is our subject and yet I don't see maths personally as a subject. I feel it can be taught in much better ways and certainly in the third and fourth form I would like to see maths taught almost entirely from the thematic approach where you look at a problem, you say 'alright we are going to totally redecorate the whole school'. Now there is a tremendous amount of mathematics that would come out of that and I think the kids would see the point of what they were doing a lot more.* (T 28)

This concern with teaching methods was not caused by a new curriculum; it preceded the development of the curriculum initiative in mathematics (Ministry of Education, 1992a and 1993). It seemed to be a pragmatic search for ways to improve teaching and learning.

processes

The processes of mathematics—problem solving, investigating, making connections, and communicating (improving questioning and discussion in the classroom) were an issue with nineteen of the respondents who felt a need to know more about them and how they might be incorporated into the curriculum. The views expressed suggested that these processes were merely a part of the content of the mathematics curriculum, or that they simply related to teaching method. They did not suggest that the processes were seen as being different but intertwined with both content and method.

content

The need for professional development related to mathematics content was raised in eleven responses. This development included reinforcing

the basics (especially with alternative courses) and helping some teachers (especially those who were not trained as secondary mathematics teachers) to gain expertise in specific areas in both mathematics and statistics where they identified a need or desire to improve their qualifications.

Seven teachers identified the need to learn new content for student courses, while associated activities with resources, assessment and scheme writing were mentioned by three, six and four interviewees.

bilingual

Six teachers involved with the bilingual units noted the shortage of fluent Maori language teachers with good mathematics backgrounds. It was suggested that this should be approached from both directions. Help is needed in getting more mathematics teachers fluent in Te Reo and help is needed to get more fluent speakers qualified as mathematics teachers. One bilingual teacher (T 24) commented,

> *The big problem to me in immersion or bilingual teaching of mathematics is this - we tend to have a lot of people who are either trained and are good at teaching mathematics but don't speak the language and then we have a lot of people who can speak the language fairly well and are keen to do it, like me, who haven't had the maths background ... a big problem of making the two things meet ... teachers who already have the maths skills, maths teaching skills, need to have time to learn the language and then for me I need to learn the language of maths.*

technology

The influence of technology—computers and calculators—was another curriculum area that evoked concern from eight teachers who felt a need for guidance in the area. Views about calculators and computers varied amongst all the teachers from some who were opposed to them, to others such as T 14 who viewed them positively.

> *I have really enjoyed having calculators. That has freed things up, amazingly. Things like calculus are just so much more fun now. You had to get concepts through before and the kids couldn't see what was actually happening but now you can have something getting closer and closer to nought and they can see what is happening. ... I am quite enthusiastic with the investigative approach so that would usually incorporate calculators or computers, where kids are finding things out for themselves, they*

get a big kick out of finding things out themselves rather than be told 'follow the track and you will get the answer and I will give you a tick when you get the answer'. So it is how to incorporate that into a scheme, into a class management.

SUMMARY OF NEEDS

The perceived professional development needs of the teachers were categorized into three groups: those concerned with the school, the person, and the curriculum. School development, teacher effectiveness, standards, equity issues, and management were typical concerns within the school. At the personal level the concerns were communication and group skills together with career planning opportunities. Curriculum issues centred mainly on teaching methods with a considerable number of concerns being expressed. Mathematical processes rather than content, mathematical knowledge, Maori language, and technology were other areas of concern and areas where a perceived need for professional development existed.

8.4 Preferred types of development activities

Having acknowledged their professional development needs, the teachers then discussed the types of development activities that they preferred to help meet these needs. Three types of activities emerged with the main difference being how they were organized. They were:

i those that are organized within a school,

ii those that are organized between schools, and

iii those that are individually initiated and have little to do with the school, although some of these such as professional associations may require a number of schools to exist in the region.

IN-SCHOOL meetings

Eighteen of the forty-six teachers perceived a need for meetings as part of their professional development—department meetings, staff meetings, curriculum meetings, and guidance meetings. However, some complaints about the large number of meetings, the time taken by meetings, and issues seen as trivial indicated mixed feelings about the value of some meetings. Other teachers did not include meetings as vehicles for professional development as, in their experience, the main focus of meetings was administration.

sharing

Sharing sessions when colleagues were engaged in joint writing and/or sharing of teaching ideas, resources, schemes and tests were the type of meeting valued by twenty-two of the teachers.

teacher-only days

The in-school teacher-only day was discussed by twenty-two of those interviewed with some adding comments about the day being very pleasant but probably not very effective. One senior teacher's (T 28) comments typified this latter view.

> *I don't think (they) are worth the sort of money that the department is spending on them. I think people tend to think on them as a day out of school and that was it. You got a lot more just from the informal contact than you did from the formal and that is the beauty of a week course; you get a lot more informal contact.*

expertise

While some responses mentioned the need to bring in experts for teacher-only days, others commented that schools had (but often did not recognize) considerable expertise, including that of the new teachers within the mathematics department. Two senior teachers (T 2 and T 25) spoke about this expertise,

> *We have some very good expertise on the staff and in general need to use this more. ... We have a good number of staff, mainly women, who are PR potential and indeed could or should be HODs. Some are immobile but many choose to remain here - the expertise of these people (under the HOD level) needs to be tapped to a greater extent* (T 2).

> *I think some of the most valuable teachers we have are year one teachers. They do or should arrive with the latest ideas. They want to teach that way. It is not always possible, ideally, but at the same time they do bring in a perspective ... we tend to undervalue those that we have on our doorstep and overate those who are outside* (T 25).

action research

Five teachers made reference to action research (involving discussion, planning and carrying out some development work) as a preferred professional development activity. Only one of these had personally experienced it and not with a mathematics focus.

observation

One-to-one interactions involving observation and demonstration lessons (both in-school and at other schools) were valued by half the interviewees. An experienced teacher (T 33) commented about this.

> *... watching other people try out things, that is good. Because I often would like to go and sit in other people's classrooms but it is very difficult to organize often. I enjoy watching other people ... well you see some of the things ... does are great, others I wouldn't do it at all, I wouldn't touch with a barge pole. She has some things that I really like but it is not very easy for me to go and watch her teach or other people in other subjects and yet I would like to. I know there are other teachers with totally different styles to me which might help me modify my style. I am eager to change.*

mentor

The mentor role of the head of department or of a colleague was significant for ten people, while with five an 'apprenticeship' relationship involving support and guidance from senior staff was considered to give more opportunities for experiencing new responsibilities. One person (T 9) speaking about this support said,

> *I worked quite a bit more with the HOD. I was actually relieving and I was relieving for his number two and we tended to communicate a lot more than I had done as an assistant teacher beforehand ... but I think I learned a lot from, not necessarily how to do things, but I learned what needed to be done from watching ...*

interactions with advisers

Working with advisers (and inspectors and liaison people visiting the school) was mentioned by eleven people as a preferred professional development activity. While some had had very little contact with advisers, others thought some arrangement should be formalized. One (T 6) commented,

> *I would like to see a more permanent long-term arrangement for secondary maths advisers especially now (after Picot).*

resources

Having access to and using a variety of resources—teacher guides, periodicals, library books, a department library, alternative teaching resources and videos—were mentioned by about half the teachers as being useful for professional development. One senior teacher (T 38) reported,

Teachers guides are good the first time you go through something new. They are really useful. And they are good for younger teachers .... Good for the people who are less confident with the subject, people coming in later maybe. At my stage I would use them only when doing something new, maybe for the first time or second time. But then after that I probably wouldn't refer to them much. ... they are more use than just a text book because they focus carefully on where you are going.

BETWEEN SCHOOLS

A second category of preferred activities involved teachers from other schools.

meetings and courses

Meetings and courses at which teachers from different schools met were valued. Residential week long courses of a national or regional nature including writing, syllabus, teacher guides, or policy, had been experienced by eighteen of the teachers and their feelings are illustrated by what one teacher (T 2) said,

I had a week at a (course) writing modules for the sixth form. That was excellent. I would like all teachers to be involved in that type of course because not only do they see the benefits of writing modules and the different ways you can approach a topic and meeting people bouncing around ideas.

jumbo days

Jumbo days (i.e. teacher-only days with numerous schools participating) were considered by twenty-seven of the teachers to be not particularly effective as with teacher-only days. Fourteen people said that courses need to be spread over a period of time. The relative value of these courses was stated very clearly in one interview (T 19),

The jumbo days and the one day things I regard as being an expensive waste of time ... I think that the Lopdell course, which I think was three days from memory, it was like six weeks packed into three days and value for money; it had to be far and away better.

examination marking

External examination marking was viewed as professional development by four people who saw it as providing a worthwhile focus for teachers from different schools to meet and discuss issues related to teaching and assessment.

others

Other schools have tried or considered more radical ways of organizing between school activities. One senior teacher (T 28) indicated some possibilities using examination time and an ex-principal (T 29) reported on some structural changes that his school had been involved in to achieve some teacher-release time.

> *... get together during examination time when there aren't so many classes to cover ... instead of money being given to the school for relievers, the money actually goes to the people concerned, and they work in the holidays ... the individual subject associations have to take that on* (T 28).

> *we wrote, in a thirteen or fourteen week term, our timetable in such a way that we would have, say, in the fifth week, what we termed interruption week in which we would take kids for alternative activities involving a lot of parents and we would release three teachers for the whole week and they would get away. We would do the same for each term. I think once we tried it, each four weeks we did the same thing and that was quite good because it gave you a focus on your teaching for four weeks. You took a block and that was what you were going to do, and although it was not a rest you got rid of all these other things that are loosely termed interruptions from the outside. I guess a lot of areas where sociologists have had a lot of say you can do things in that week and not feel bad about it. It allows you to do outdoor education, you can do all sorts of other things but it means that the other area of your timetable stays uninterrupted. The vital thing was getting teachers away to other schools* (T 29).

INDIVIDUALLY INITIATED

A number of preferred professional development activities were seen as individually initiated rather than organized by the school or between schools.

reflection

The most personal activity was a form of simple reflection—personal reflection and reflection aided by peers, reading notes, or a teacher-spouse. Nineteen responses recognized this as an important development activity. Two comments (T 18 and T 39) illustrate this:

> *Well I personally change everything because I can see a fault that is coming through, something that I haven't done properly to get the result, then I would go back and say to myself 'why' and then*

slowly change my whole approach, emphasis maybe and to write what I know I didn't do completely right the first time. I might have been only eighty percent or ninety percent right (T 18).

I developed a habit, after a while, of keeping careful account of what I did one year and what was successful and what was not successful, particularly in relevance to text books that we might be using so I didn't make the same silly mistake and use a poor example the following year. I have also put a lot more of my work onto computer disks so that I can reuse it by just adjusting types of questions. Basically it is the same but it saves a lot of rethinking if it is all there (T 39).

courses and meetings

While courses and meetings that involve numerous schools are usually thought of as activities between schools, teachers reported using their own initiative to participate in a number of them. These included:

i teacher refresher courses (11 responses);

ii local mathematics association activities (16);

iii networking (similar to mathematics association activities but with a sharper focus and often less formal meetings (15): these include bilingual teacher networks, equals groups, family maths, HOD cluster groups, local maths certificates, and the DP/AP associations;

iv national/international association conferences (19)—this number was possibly due to the recent experience in August 1989 with the 1st NZ Assn of Mathematics Teachers Conference and in anticipation of the 3rd International Conference on the Teaching of Statistics.

One comment (T 6) was,

the turning point was my attendance at week long teacher refresher course where there was considerable discussion and time to reflect on this, ... Involvement with the Bay of Plenty maths association, the NZ Maths Certificate committee and three writing groups over the years has (also) provided fresh ideas, time to reflect, and time to debate with colleagues regarding my teaching.

study

Individual study (university research, night class and advanced study for teachers, either by attending courses or working extramurally with

correspondence courses) was mentioned by twenty-four people as useful. Some difficulties were experienced such as getting time to undertake study. As one teacher (T 6) said,

> *I applied twice for PPTA years study leave—unsuccessful—obviously more of these are needed—but I wanted an opportunity to "plug some gaps" in maths and education to improve my work as a teacher. These subject "fill-ins" (by this I mean more study in mathematics, not just the teaching of it) do not necessarily need a full year off but that would be a good way to do it.*

life experiences

Over half the teachers commented on the value of broad life experiences such as working in other schools, being parents, and travelling overseas. For example, one teacher (T 41) explained that becoming a parent had had

> *... an incredible effect. I am much more realistic in my approach to the students. I think being a parent you really have a feel for what has gone before but this isn't a child that is in your classroom, there are all sorts of other things going on in their lives apart from their school life. The pressures that they are under and their ups and downs. ... It is interesting because with some of the young teachers - the ones without children who sometimes tsk tsk about the behaviour of some of the kids and I just smile to myself and think 'just give you a few years mate'*

SUMMARY OF ACTIVITIES

In summary, the preferred professional development activities were categorized into three groups: in-school, between schools, and individually initiated. The comments about these activities were based on prior experiences; the teachers had very little to say about other possibilities that could occur in the future.

The in-school activities were all organized within the school, including meetings, in-service days, shared tasks, visits from experts, action-research or doing other forms of research, one-to-one interactions with observations and mentors, induction activities and the provision of resources such as teacher guides, periodicals, and alternative texts.

The between-school activities were those organized by liaison groups with very close links to the schools or by other groups within the formal educational bureaucracy. The types of activities included

meetings (week-long residential meetings and meetings spread over time were preferred) and observation of colleagues in other schools.

A number of activities that were organized outside the formal educational structure and which involved individuals initiating participation were valued. These included personal reflection and meetings—courses and conferences (teacher refresher courses, and association conferences) and network meetings.

Study to improve qualifications was a third broad area of development activities while the broad experience gained in other schools, as parents, in other work, and overseas were all seen as contributing to the individual teacher's development.

8.5 Influencing factors

Two types of factors were perceived by the teachers as aiding or impeding professional development. These related to the administration of development (the main two being time and resources) and the organization of development to take in the affective aspects (acceptance of feelings and provision of support).

Time

Time was seen as important—time to reflect, time to debate, time to try things out, time for sharing and time for listening to others. This time was usually thought of as 'meeting' time and the need to organize for meetings of one sort or another was identified by all of the teachers.

Two comments (T 11 and T 20) illustrate the need for extended time,

> *... really good because of hands on activity for an extended period and the follow up* (T 11).

> *... having the time at the start to be getting, if you like, hands-on or minds-on experience. It is the workshop session, if you like, rather than the lecture session* (T 20).

The need to spread activities over time so that participants can think things through was seen as important and was expressed well by one head of department (T 16) when talking about the change process,

> *When I am trying to bring about a change, I introduce an idea into some discussion point and it seems to me, in our department, we*

have almost an explosion every time something like that happens and I think that is really healthy. There is this really active assertive, almost aggressive venting of feelings which I think is really good. I often let the dust settle after that. I do think some of them do go away and reflect because quite often if I am in the staff room at interval or something like that, one of them will come up and make a statement to me, maybe even a week later and they have been chewing it over. I think that is a really important process. I know that they talk to each other. Often they will talk in a negative way, have a good old moan, it is going to be too much work ... sometimes I overhear those conversations but I think that is all good ... I do think I throw questions at them ... over a series of hits and in actual fact, I mean I have been here eighteen months and some of them are still talking about the same issues as when I first arrived, but I can see where they have moved along the continuum.

Another time related question is whether development time should be school time or the teachers' own time. Twenty of the teachers felt that school time needed to be provided for development activities while eight suggested that their own time could be used. Using holiday-time was mentioned as part of teachers' own time but family commitments were seen as a difficulty.

Resources

Another factor that influences professional development is resources and as most resources can be purchased, the focus in thinking about resources is usually money. At the time of the interviews the restructuring of educational administration meant that schools were starting to budget for professional development and were beginning to write professional development policies. Budget allocations varied from about $160 to $400 per staff member with smaller schools and more remote schools generally budgeting proportionately more to cover their additional travel costs.

The cost to individuals of fees, travel and accommodation was viewed by seven teachers as a disincentive, while the cost to schools was thought by ten to be a problem. Two responses suggested that individuals should be paid to be involved in professional development, arguing that it is cheaper and less disruptive to pay $100+ for teachers

to work in their own time than to pay for teacher relief ($250). An administrator's (T 1) comment was,

> *I guess we are going to look much harder and longer as to whether a particular course is directly relevant to our school. We are going to be very much more hard headed about whether we share out those precious dollars.*

Inadequate study leave opportunities were viewed as a time and resources constraint by three teachers; possible problems with the availability of relievers was mentioned by a different four, and the lack of alternative resources such as texts was mentioned by two others.

Others

Other factors that were perceived to help or hinder professional development were related to the difficulties of rural schools, the need for communication between schools, and the need to identify needs.

Rural schools were seen by eleven as having a number of special difficulties related to their isolation, the distances for travel, and their small size. The Principal of the rural school (T 5) commented,

> *In my opinion it would seriously disadvantage us. ... for example I have a first year teacher at the moment and I have to send her to Hamilton or Rotorua to even observe another teacher in action. Day to day or week to week interaction of schools can be very important but for us, as I said, it means we have to travel before we can have any interaction or take part in any professional development.*

The need for good communication between schools (based possibly on the old model of in-service committees) was valued by five and the lack of direction given by the Ministry was seen as a disadvantage by two.

The need to identify teacher needs first was seen as important by five and strategies such as job analysis, job specifications, staff appraisal, and staff profiles were mentioned by six people as possible ways to help achieve this. One head of department (T 16) expressed this as,

> *... starting with consultation and finding out where the person is at and telling them what the alternatives are, what we can offer.*

Feelings and support

Change involves both positive and negative feelings and support can come in various forms. Eight teachers commented on the importance of having a 'critical number' of people from a school at an activity. The desire was to ensure that enough people (but not too many) participated in a new development so that it could be sustained. This seemed to be linked with both the desirability for informal discussion with peers that teachers had mentioned and with the need for support that emerged in the literature. Two views (T 19 and T 6) expressing this were,

> ... *when I came back ... I was fired up and enthusiastic and ready to get in and sort things out and what I came back to was a maths department that hadn't been on the same course as me and I felt at the time that we probably would have been more effective to have taken our maths department and when we came back we would have set this place alight. I think that would have been a more effective way of doing it* (T 19),

> ... *more support because I attended this teacher refresher course with a colleague so we were able to continue the discussion and lobby for resources when we returned to school* (T 6).

The need for a school climate where support to change and positive reinforcement for innovation and growth was forthcoming was mentioned by seven teachers. This support needs to initially encourage teachers to participate in development activities and then to value what they learn and encourage them to try things out within the school. Two comments (T 35 and T 32) showed this need clearly,

> ... *courses are always offered so if you want to apply you apply. Every now and then somebody will come and suggest it to you or perhaps say 'I think you should look at doing this now'. Statements are made with really not much depth, it depends who you get on with up here. If you get the right push in the right place* (T 35).

> *Most of my classes are happy and I have been told that I am a good teacher but it is interesting that people above you will often tap you on the shoulder if something goes wrong and it is this constant being tapped on the shoulder for the things that have gone wrong, or may. For example, some of my boys last period on Thursday escaped before the bell and I was tapped on the*

shoulder about that. It is little things like that which are almost constantly telling you that you are not quite up to the grade and it is upsetting. If someone tapped you on the shoulder and said "look gee that was a great idea that you had" or "that was a good lesson" I think you would go from strength to strength. But it is the tapping on the shoulder for the little things that you don't do or that you forget (T 32).

The need for report back and follow up within the school to ensure that something happened and as a way of valuing the experience was mentioned in eleven responses. One (T 20) spoke of,

The need when planning something to have probably about three to six weeks and then a follow-up on that to bring people back together again to see what you have very quickly sketched over and thrown to people to interpret in the way that they were going to interpret it. Just bringing that and seeing what has happened about that.

The desirability for a head of department to be supportive and to facilitate development was viewed as important by three. The reported experiences of eighteen were that their heads of department had been available for help but had not initiated development activities. One head of department (T 16) saw the role as,

it is my responsibility ... to facilitate their professional development because I actually am in very close contact with my teachers and I know those people. I make a point of knowing if somebody's father is living with them and causing problems or if a teenage daughter is causing problems. I know all those things and I am in touch with those people. I actually think probably I am one of the best people to facilitate and put them in contact with the right people. I certainly don't think I have to give them all the professional development but I think I have to play a very major role in facilitating it. And being there to pick up the pieces when it doesn't go right.

The entrenched views of a small number of older and more traditional teachers who were not supportive of change were viewed as a difficulty in five responses.

The need to have an opportunity for communicating feelings was mentioned by two people and the role that cognitive conflict plays in the change process was alluded to by one, a head of department (T 16),

> *I think it is just an inherent part of change but they are insecure because they are having to confront some questions themselves instead of being in a secure situation where someone is saying 'right I want you to do this and this and this and this is the way to go about it'.*

Administrative support seemed to be needed in situations related to relief teachers and discrimination. While being away from school for courses was seen as advantageous by four, one teacher mentioned the problem of disruption to one's class while away. Four teachers felt that women, part-timers, and relievers were all discriminated against when it came to opportunities for development. One comment (T 29) about discrimination was,

> *... it does matter because if I look at my wife, she has a Masters, is a fine all round teacher, a better administrator than I am, and yet she never got those opportunities so in some ways it was also, again, male dominated, male orientated.*

Two teachers spoke of their dislike of being observed if it was done critically rather than supportively, and one spoke of a fear of failure. One teacher (T 32) replied, when asked how she felt about teachers visiting her classroom,

> *If I knew what that teacher was there for, not to criticize but in a supportive way, then I would have no problems with that and, in my remedial capacity, I am often in other people's classes and I hope I don't pose a threat to them in that situation. Yes, as long as it is done in an encouraging and supportive way.*

Summary

Adequate time and resources were seen as essential for successful professional development and other administrative factors were discussed. The role of positive and negative feelings in the growth process and the need for support were also acknowledged.

The discussion of time included the purposes for which it is needed, the need to spread activities over an extended time; and the need to consider whether activities should be during school time or teachers'

own time including holiday time. Limited resources, in particular money (related to teacher relief, travel, and course fees), were seen as likely to put restrictions on development.

Other factors that were discussed were associated with the isolation and small size of the rural schools, the need for communications between schools (because of the lack of direction given by the Ministry), the need for any development activities to be structured to include hands-on experience, and the basic need to first identify teacher needs.

In acknowledging the place of feelings, comments focussed mainly on support from colleagues at courses and on return to school, and mentioned related activities such as informal discussion, report back and follow up. The styles of working of the heads of department stimulated considerable comment, the experience of most teachers being that these were reactive rather than proactive styles.

8.6 Some comments and conclusions

In this chapter the responses of the teachers to questions about perceived needs, preferred activities, and influencing factors have been documented. Throughout the interviews the teachers talked about professional development activities in terms of teaching, what they do as teachers and what practical ideas they could use in the classroom.

Virtually all the teachers and the senior staff assumed that the types of professional development that existed in the past were the sort of activity that should continue and that they only had to identify the content for such activities. The schools had been involved in writing charters and were aware of the need to take responsibility for professional development because of the changes since the recent past where inspectors, curriculum developers, and other 'experts' organized development activities and teachers merely signed up for the courses.

Overview

The impression gained by the researcher was that the interviewees did not have a good overview of the professional development process or how to manage it. The two prevailing views were matching people against lists of available courses, and making up for deficits. While time for development was mentioned this did not seem to be linked with time for such components of development as experimentation,

reflection, feedback and support. It became evident that managers of professional development (probably heads of department) need to

i develop a better understanding of the development process,
ii ensure that professional development activities incorporate the necessary components to make it effective, and
iii help develop an ethos for change within the school.

The teachers were aware that resources for development are generally limited. In looking for evidence that suggested a consideration of cost-benefits, all that was noted was the suggestion that only people who want to be involved in projects should be. The allocation of resources was mainly on a department basis with some departments getting a little more because of initiatives within their subject. Some departments simply used resources until they ran out on a 'first in, first served' basis. At the same time it was evident that only part of the development work that was needed had a subject basis (although some, such as teaching methods, were perhaps seen as best considered in the context of mathematics). Apart from development associated with induction and new teachers, a cross-curriculum context for development activities did not seem to be used although this offers an option that may need to be explored in the future.

Linked to the issues of the overall process of development, the development of an ethos of change within the school, and the practical problem of limited resources is the question whether outsiders or in-school colleagues should be used in development activities. Many teachers looked outside for help but others admitted that their staffs included colleagues whose potential was unused. In terms of the input of new ideas about development and for development, outsiders are able to inform the discretion of teachers, but such information can also be obtained from other sources such as professional reading and curriculum documents. In terms of an in-school focus and ongoing support, it is unlikely that schools would stretch to cover the use of outsiders for more than the initial stage and, in time, the in-school expertise and confidence may be developed to make the use of outside expertise unnecessary.

Equity

Two equity issues emerged for the researcher. The first was an apparent trend for women heads of department to be more reflective and more involved in professional development activities. Further research into this might ascertain whether gender was the critical factor or whether age, length of time in the head of department's position, or experience away from teaching was more important.

The second equity issue emerged in the three (of the six) schools with some form of bilingual unit. Staff in these units indicated a sense of isolation, conflicting loyalties to the mathematics department and the bilingual unit, significant language needs or a mathematics background requirement, and a shortage of appropriate resources. The stress on teachers in these positions has been identified by Ohia, Moloney and Knight (1989 and 1990). This group appears to have particular needs which require extra development resources.

Research questions

The research questions investigated by this project are:
What are the professional development needs of high school mathematics teachers? and How will these needs best be met? The views of these teachers provide one perspective on these.

The study revealed a diversity of needs and the variety of considerations that need to be recognized in planning a professional development programme. Schools need to spend considerable time in ascertaining where teachers are at, and considering a range of activities that would be suitable in their school and in their district.

The diversity of needs also implies that a school may not be able to satisfy all the teachers within it so mechanisms need to be available for these needs to be met elsewhere. Further, schools need to balance the needs of the school as a whole with the needs of the individual teachers.

The research questions can be answered more fully when consideration is also given to the views of other professionals, official policy statements, and knowledge about the process of teacher change.

CHAPTER 9 MATHEMATICS EDUCATORS' VIEWS

9.0 Contents

9.1 Mathematics educators 129
9.2 Questionnaire 130
9.3 Analysis of data 130
9.4 Professional development requirements 131
9.5 Types of development activities 134
9.6 Influencing factors 135
9.7 Conclusions 137

9.1 Mathematics educators

In mid-1989 the high school mathematics educators had a one-day meeting linked to the first New Zealand Association of Mathematics Teachers conference in Hamilton. With the impending restructuring of educational administration it was known that some of these people would assume new responsibilities. This was an opportunity to seek their insights about mathematics education while these were uppermost in their minds. A questionnaire (appendix B, p.226) was sent out before this meeting for them to reflect on and to document their concerns—this provided a focus for the meeting and information for this research. This questionnaire was sent to 31 mathematics educators. These were the inspectors, teachers college lecturers, seconded secondary mathematics advisers and primary mathematics advisers who had had contact with high school mathematics teachers. Details of the sample and responses are shown in table 9a.

Table 9a Sample of Mathematics Educators.

Type of mathematics educator	Number sent	No. of responses
secondary inspector	8	5 (#E1 to E5)
teachers colleges lecturer	6	4 (#E6 to E9
seconded secondary adviser	2	1 (#E10)
primary adviser	15	5 (#E11 to E15)
Total	31	15

The first three categories had the greatest contact with high schools and 10 of the 16 (62%) responded. Many primary advisers had little contact with high schools and may have felt it was inappropriate to respond. Their response rate was 5 out of 15 (33%).

Ten of the fifteen respondents (E1 to E10) had worked closely with the researcher in the preceding five years while his role was curriculum officer with responsibility for high school mathematics and may have been influenced by his views. These ten, who had worked in the high-school sector, commented more fully than those with a primary-school focus to their work. Their close association in the past included annual planning meetings where most of them met with the researcher for a week to plan priorities, and other national and local meetings where they had been involved together on projects.

9.2 Questionnaire

The questionnaire (appendix B, p.226) comprised open-ended questions to allow respondents to outline their concerns about mathematics teaching based on their observations at forms 1 and 2, 3 to 5, and 6 and 7. The questionnaire sought to elicit both concerns and priorities for teacher development. Some responses could be interpreted as reflecting a deficit view of professional development but this is possibly a result of the way the questions were asked.

9.3 Analysis of data

From a preliminary reading of the responses the data indicated that:

i differences between the concerns and priorities at different levels of the school (forms 1 and 2, 3 and 4, and 5 to 7) were slight, and

ii there were almost no comments about teaching in the broader context of education.

This suggested that data might be clustered somewhat differently from the way suggested by the questionnaire. On further inspection it seemed that the responses fitted more naturally within the framework used with the teachers' responses. Consequently this framework was used although during the analysis some different subheadings emerged. All the subheadings are shown on the framework in table 9b.

Table 9b Headings used as a framework for analysis of questionnaire responses.

Professional development requirements - school, people, curriculum, learning theory
Types of development activities - in-school, between schools, individually initiated
Influencing factors that aid or impede professional development - time, resources, feelings and support, others

9.4 Professional development requirements

SCHOOL

Three main areas of concern with respect to mathematics in schools were mentioned. These were a restricted focus, negative student attitudes, and problems with the range of student needs.

narrow focus

Four respondents expressed concern that the overall purpose of mathematics education as contributing to the development of whole people was often lost in the narrow subject view reflecting the fragmented nature of the curriculum at the secondary level. This suggests a need in development to take a broad focus. One of the inspectors (E 5) put it this way,

> *teachers see their own curricular areas in isolation and do not fully appreciate the overlaps which occur in the areas of skill and attitude development ... (they need) to see the curriculum as a whole and develop concepts, skills and attitudes through an integrated approach, similar to that which happens in good primary schools.*

negative student attitudes

Six respondents commented with concern on the negative attitudes towards mathematics learning that had been observed among many secondary students. They wrote of students being "switched off", "bored" and lacking in responsibility for their own learning. An inspector (E 3) remarked,

> *I talk with students in class and ask to see the work they have enjoyed most, found easiest or hardest, etc, and ask them why. I guess 50% look at me with horror to think they could enjoy any mathematics, 5% enjoy all of it, 40% point to a repetitive exercise in which they succeeded and 5% point to a geometrical activity.*

This concern about the negative attitudes implies that development may need to address the issue of making mathematics relevant for students.

inequity

Concern was expressed in seven of the replies about the need to address the difficulties of accommodating the most able and the least able students and to develop appropriate programmes for all students. As one primary adviser (E 15) commented, there is an urgent

> *need to cater for differing levels of ability.*

Problems relating to mainstreaming of "special needs" children were not sought by the questionnaire but were expressed later by two different seconded secondary advisers.

One respondent expressed concern that a largely monocultural view (European) prevailed in high school mathematics teaching and two considered that teachers needed to be made aware of gender issues so that girls were not disadvantaged when learning the subject.

PEOPLE

Three groups of staff were identified as having special development needs, or being in need of extra support—heads of department (especially new ones), untrained teachers, and non-specialist teachers or teachers of other subjects asked to teach mathematics classes. The non-specialist teachers were considered by one inspector (E 3) to often lack confidence in teaching mathematics, while two replies suggested that heads of department needed training to help them adapt to their new roles and responsibilities. One inspector (E 2) commented,

> *Heads of department should be given opportunities for a five week secondment to the Teachers College as a member of the staff of the mathematics department.*

CURRICULUM

Teaching methods, content, resources and assessment were the main aspects of curriculum that the educators commented on as needing to be the focus of professional development activities.

restricted teaching methods

All but one of the mathematics educators expressed serious concerns about teaching methods. These included,

> *the inflexibility of teaching,*
> *lack of variety in lessons,*
> *rote teaching,*
> *teacher and textbook dominated programmes*, and
> *minimal use of equipment.*

Specific concerns expressed in the replies included the need to have:

i a variety of teaching approaches
ii more student-centred mathematics lessons
iii problem-solving lessons
iv less text-book-orientated teaching
v practical work with concrete objects
vi relevance to all students
vii encouragement to develop independence in learning
viii more emphasis on communication in the classroom
ix a greater acceptance of new technology (calculators/computers).

These specific concerns about 'teaching methods' included some of the 'processes' of mathematics but these were not separated out by the respondents.

The need for development activities to enrich the teaching of mathematics was expressed. One primary adviser (E 15) made a plea to provide teachers with help to enable them to

> *make mathematics come alive*

and an inspector (E 4) sought

> *anything which increases the vision of teachers and helps them to add interest or motivate students.*

inappropriate content

Nine of the educators were concerned that the content of some mathematics courses was inappropriate for many of the students. This was best summarized by an inspector (E 5) who said,

> *much more relevant training should be given to all teachers, both pre-service and in-service which will enable teachers to accurately establish base lines of achievement for their students, and then devise programmes which will meet the needs of the students rather than the current practices which appear to fit students into preconceived programmes, and may or may not have any relevance for the particular aspirations of either the students or their parents.*

restricted use of resources

Another perceived professional development need related to using resources other than textbooks. Nine of the replies suggested that too many teachers allowed their teaching to be dominated by the text book and showed an unwillingness to use alternative resources. One primary adviser (E 11) said,

> *Available resources are very limiting; more accommodating resources are essential, more interactive and compatible resources.*

Three responses indicated that plenty of resources existed (in most but not all schools) but that teachers did not always know about them or where they were stored. They were sometimes

> *confused by the flood of resources* ...[that were often] *poorly stored and underutilized* (E 2).

assessment

Professional development related to assessment was identified as a need by ten respondents, with assessment for senior awards being referred to by five of these. The specific need to develop suitable objectives for efficient assessment for awards, and methods that were not too time consuming were seen as important by three of the five.

Formative assessment to see if students really understand and to establish stages of pupil development was identified as an area needing attention by one primary adviser (E 15) who spoke of,

> *evaluation techniques to establish* [the] *stage of pupil development.*

LEARNING THEORY

Three inspectors and one primary adviser felt that more understanding about how students learn would be useful for teachers. They claimed that a lack of understanding of learning theory exists among teachers and that curriculum and resources consequently far outstretch the ability of teachers to make use of them. The primary adviser (E 11) said that there is

> *a need to shift present agendas of transmitting understandings to a child to an understanding of how a child understands as she makes meaning for herself and constructs her own personal knowledge ... a need for more interactive learning environments ... a move from whole class teaching to group teaching with greater consideration of individual needs and constructs ... a need for teachers to think beyond the computational requirements of the syllabus, and to start viewing children as active mathematical thinkers.*

9.5 Types of development activities

The types of development activities that were suggested were classified on the basis of whether the initiation of the activity would be from within the school, within some regional grouping, or by an individual. As with teachers, these suggestions seemed to reflect past practices; the responses did not indicate new ways of looking at professional development.

In-school

The in-school activities suggested by four replies included the normal range such as in-service courses, mathematics department and school-

staff meetings, working with (and along side) individual teachers, assessing programmes in action, and induction programmes (for List A teachers).

Between schools

Networking and on-going in-service rather than one-off courses was preferred by five of the six respondents with respect to district in-service. Some form of centralized pre-service/in-service programme (including liaison between colleges of education) was seen as being needed. One inspector (E 4) spoke of,

> *clear liaison between schools and mathematics associations, greater communication between schools through formal and informal networks, liaison between colleges of education and associations and schools, ... continued regular district and national conferences and in-service.*

One might interpret comments about teachers helping themselves, networking (formal and informal) and associations, as suggesting that greater emphasis be given to the non-department/non-ministry organizations as a focus for development. This might be appropriate in the environment created after the 1989 restructuring, but four of the responses made it clear that these were additional to regional and national courses and that support for meetings and conferences of associations and networks was seen as desirable.

Individually initiated

University study, action research and development opportunities were seen by five respondents as being needed, while more activity from the associations in setting up special interest groups (research, motivation, contract committee, syllabus committee, HODs , advisers) was viewed by another as a way to make it easier for teachers to initiate their own professional development outside the school setting.

9.6 Influencing factors

The questionnaire did not specifically seek views about influencing factors but nine of the respondents included comments about such factors and it is likely that a greater response would have occurred had the area been probed directly. The comments fell into three particular categories and one general one.

Time

Four of the five inspectors and two other people commented on time as a critical factor for effective in-service work and said how it was needed for planning and follow-up as well as for the in-service work itself. One inspector (E 4) commented,

> *... courses are often constructed to tell others how to do it rather than to enable learning to take place—and that enabling cannot be done on a one-day basis; it requires reflection and questioning over a period of time, in a supportive group of teachers who are working together to overcome common problems.*

Professional development needs time for *"feedback loops"* was one lecturer's way of referring to the need for time for effective in-service.

Resources

While time is obviously a scarce resource, and money that can buy time may be regarded as another, the two inspectors who commented on resources were referring to 'teaching idea' resources or teachers guides that related to teaching activity and might be used as starting points for development. For example, one (E 3) mentioned the

> *lack of an 'ideas' book to suit the syllabus.*

Feelings and support

Within professional development the need for supportive help and encouragement for different mathematics staff came through in four responses. This included support for:

i new teachers from teachers colleges,
ii isolated teachers,
iii the development of local support groups,
iv teachers being responsible for their own professional development,
v mathematics technicians in large departments, and for
vi teachers to lead networks.

This support was not merely back-up and professional support, but also support in the affective area. One inspector (E 3) was concerned with the

> *isolation between teachers ... development of locally based, support groups and activity packages to support the development*

and one lecturer (E 7) spoke of

> *too few sessions on sharing and caring with colleagues.*

Other factors

Other factors that were each mentioned by one respondent included

i a feeling of frustration with
a recognition of need for change but little space to do so ... finding a model for ongoing change and development (E 6);

ii the need for ownership of a development, the
need for teacher involvement in module development (E 6);

iii the need for development to arise from a needs assessment (E 14);

iv a concern about smugness was observed by an inspector (E 3) who reported
specialists thinking they've got it worked out.

9.7 Conclusions

The brevity of this chapter reflects the limitations of a questionnaire. In hindsight it may have been preferable to interview these people in a similar way to the teachers. Nevertheless, a range of useful perceptions was obtained. perhaps not surprisingly, the responses were similar to those expressed by the teachers. These respondents were closely associated with teachers and in many instances had recently been teachers in the classroom. A comparison of views of the teachers and the mathematics educators is left to chapter 10, which also includes a comparison with ideas from the policy documents.

Two points in particular, seem noteworthy:

i Negative attitudes of students identified by the respondents are evidence of student discontent about programmes and indicate a need for development that addresses the cause of the negative attitudes.

ii While the need for an understanding of learning theory was not identified by teachers, it was mentioned by three inspectors and one primary adviser. This fits with their own reading within mathematics education.

CHAPTER 10 VIEWS FROM POLICY DOCUMENTS

10.0 Contents

10.1 Policy documents 138
10.2 Analysis of data 140
10.3 Professional development 142
10.4 Professional development requirements 144
10.5 Types of development activities 153
10.6 Influencing factors 155
10.7 Conclusion 159

10.1 Policy documents

The term 'policy documents' is used to describe official and unofficial documents and reports issued by the New Zealand Department (later the Ministry) of Education, as well as a number of non-government and overseas reports and guides. These published policy documents relating to both mathematics and general education were searched to find both direct mention of, and implications for, professional development. Fifty-three documents, published between 1976 and 1991, were searched (see appendix C, p.229). The types of policy documents are shown in table 10a below.

Table 10a Types of policy documents

Country	Type of document	Number of documents
NZ	High school maths syllabuses	2 (D 1 to D2)
	High school maths teacher guides	9 (D 3 to D 11)
	Education reports	27 (D 12 to D 38)
	Non-government reports and guides	5 (D 39 to D 43)
Overseas	Mathematics reports (UK-5; USA-4; Aust-1)	10 (D 44 to D 53)

Syllabuses and Teacher Guides

The syllabuses and teachers guides searched were those current in schools. They covered all areas of the high school from forms 3 to 7, while the draft syllabus covered alternative courses in senior classes.

The production of the mathematics syllabuses and guides in New Zealand involved a significant teacher input. These experienced teachers had been identified by inspectors and by groups they were representing on working parties as leaders in their field. In his previous role as

curriculum officer the researcher was also involved in the production of nine of the eleven New Zealand mathematics documents (D1 to D9). From the researcher's observations during the development of these nine documents two points emerged:

i Involvement in the document development provided the teachers with an opportunity for considerable reflection on their work.

ii The documents were largely based on the teachers' experiences and significant alternatives were not often considered. For example, the use of interactive teaching (Biddulph and Osborne, 1984) which is well documented in New Zealand was not considered by these teachers when they could have been looking for alternatives to traditional transmission teaching.

These two points are interrelated. While involvement provided valuable professional development for these teachers and gave them an opportunity to reflect, the documents may not have been as innovative as they could have been because the teachers were only just becoming more reflective and did not have enough time to identify the sorts of factors that have been identified in the literature review in this thesis.

The researcher had expected the views expressed in the New Zealand mathematics documents to be similar to those expressed by mathematics teachers and educators because the mathematics education and teaching community in New Zealand is small with leadership being provided by an even smaller group. The material in the syllabuses and teachers guides had many similarities because a number of the same people were involved with more than one publication and because some of the documents were concerned with the same issues. For example, D5 and D6 were guides to help teachers interpret D2.

New Zealand Reports

Over the last few years a number of reports have been submitted to the New Zealand Department of Education or published by them (or by their regional offices) or other groups interested in aspects of secondary school education. These reports have addressed such topics as teaching and learning, teacher development and mathematics.

Four of the reports (D26, D30, D41 and D43) were mathematics specific—comments about professional development in the others were relevant to mathematics teachers in their general role as teachers.

Overseas Documents

The ten overseas documents (D44 to D53) were chosen because they were national rather than local documents, and known to be influential in the New Zealand mathematics education setting.

10.2 Analysis of data

The documents were analysed by reading, noting all the parts that had relevance to professional development, looking for emerging categories, and then categorizing the data. The *Review of Teacher Training*, (D 36, p.77–79), written in 1979 summarized the areas for in-service. It listed six main areas and a number of subheadings:

- *Changing Teacher Styles:* move from didactic approach to other teaching strategies, non-streaming, co-operative learning programmes, blurring of subject boundaries, new technology.
- *Curriculum design:* broadening curriculum (e.g., human development and relationships), more local curriculum initiatives, relevance, increased technology
- *Community influence:* more links, more openness, multicultural and multiclass teaching
- *Changing nature of students:* changing societal norms, increasing need for understanding of human relationships, increasing average age, unemployment.
- *Demands on Teacher:* greater personal demands, more stressful, need for counselling skills, involvement in cooperative decision making, continuous curriculum review, widening range of students to be catered for.
- *General:* more professionalism, more autonomy of schools, larger schools, internal assessment, paradox of liberal climate and back to basics.

Eleven years later, in 1990, the *School Development: Review of Advisory Services* (D 15, p.29) made similar points:

> *The school development service's tasks are to facilitate development in three overlapping areas:*
>
> - *Curriculum - Updating and broadening teachers' knowledge, introducing curriculum changes, improving teachers' skills, developing and modifying learning and assessment strategies, and teaching and learning resources.*

• *School - Training staff other than teachers, classroom and school management, implementing change in the school, improving consultation, and training trustees.*

• *Personal - Induction and training of all new staff, senior staff and principals; personal skills such as assertiveness and effective communication, learning for management, guidance and new career developments.*

A noticeable difference is that there is more emphasis in the later report on management, induction and personal skills. As with earlier chapters in this thesis, most of the ideas on professional development could be grouped into three main categories—content of professional development activities, types of activities, and factors influencing development. The sub-headings are a little different and a new category, professional development (need and responsibility) emerged. The full list of headings and subheadings are in table 10b.

Table 10b Categories of data from the policy documents

10.3 Professional development
- Need
- Responsibility

10.4 Professional development needs
- Curriculum
  - Mathematical content
  - Mathematical processes (problem-solving, modelling, reasoning, communication, connections, technology)
  - Learning
  - Assessment
- Equity
- School (management, guidance, consultation, others)
- Personal (general, induction and supervision, career planning)

9.5 Types of development activities
- Regional
- School-based
- Individually initiated
- General

9.6 Influencing factors
- Time
- Resources
- Feelings and Support
- Leadership
- Process
- Other Influences
- Ideas

10.3 Professional development

Need

The *Review of Teacher Training* (D 36) contains a number of references to the need for and planning of continuing education for teachers,

> *teachers like other professionals need regular opportunities for renewal as persons as well as teachers* (p.44)

and later

> *the majority of teachers remain as classroom practitioners throughout their career. They need stimulation, support and recognition to maintain enthusiasm and job* satisfaction (p.45).
>
> *... That teacher education be planned as a continuing process from initial preparation, through induction, and on to in-service training with the cooperation, resources and organization that this implies* (p.73).
>
> *... That further opportunities for continuing education be provided for teachers to enable them to update and extend their knowledge of curricula, refine and develop teaching skills and adapt to changing professional needs* (p.73).

Mathematics counts (the Cockcroft report, D 48, p 217) also emphasized the need for the professional development of practising teachers,

> *Even if greatly increased numbers of teachers who are well equipped to teach mathematics were to enter teaching in primary and secondary schools in the next few years, it would take many years for this to have a significant effect on the overall quality of the mathematics teaching force. It follows that any improvement in the standards of mathematics in schools must come largely as a result of the efforts of those teachers who are already in post; they must, therefore, receive all possible support to enable them to improve the effectiveness of their teaching.*

Responsibility

The answer to the question of who should take responsibility for professional development seems to be changing as the devolution of administrative responsibility from the central bureaucracy proceeds. Three questions arise: who decides the content of development activities? who organizes the activities? and should there be central decisions about these matters, or is it the case that professional development implies bottom up change (consensus and collaboration) (D.50)?

Towards Partnership (D 38, p.75) favoured the latter and recommended that

> *... schools develop school-based teacher training which*
> *considers the aims and objectives of the school,*
> *considers student needs,*
> *includes curriculum development,*
> *improves techniques of assessment and evaluation,*
> *provides training for future positions of responsibility, and*
> *stresses communication with parents and other citizens.*

However, this report also saw a role for central administration, especially with respect to senior staff (p.79),

> *... the Department of Education be responsible for the provision of administrative and management training of teachers, especially those occupying senior positions within the schools, of its own officers, of secondary school board members and of those employed by boards.*

Ten documents addressed this issue of responsibility to some extent. Various documents recommended that professional development should be the responsibility of:

the individual	(D 15 16 30 49 51)
the school	(D 15 16 21 30 49)
advisers/consultants	(D 53)
colleges of education & universities	(D 15 36 49)
professional associations	(D 49 51)
the system	(D 16 38 49)

When responsibility was placed with the school it was still uncertain where final responsibility lay. The head of department, the professional development coordinator, the principal, and the board were all mentioned as having responsibility.

The US publication *Professional Standards for Teaching Mathematics* (D 49, p.7) spoke of

> *the responsibilities of ... :*
> *- policy makers in government, business and industry*
> *- schools and school systems*

- *colleges and universities*
- *professional organizations*

which assumes that all of these groups have some responsibility for professional development.

Only one document (D 15) spoke of the role of private providers but it warned that some had *style without substance* (p.26).

10.4 Professional development requirements

The requirements in terms of the content of professional development activities suggested in the documents cover the range of curriculum, equity, school and personal development needs.

Curriculum

Curriculum is often defined as all planned activities that occur in the classroom. In mathematics therefore it includes mathematical content and processes, learning and teaching methods, and related issues such as assessment and the use of technology.

The *Professional Standards* (D 49, p.1) summarized this view:

The image of mathematics teaching includes elementary and secondary teachers who are more proficient in

- *selecting mathematical tasks to engage students' interests and intellect;*
- *providing opportunities to deepen their understanding of the mathematics being studied and its applications;*
- *orchestrating classroom discourse in ways that promote the investigation and growth of mathematical ideas;*
- *using, and helping students use, technology and other tools to pursue mathematical investigations;*
- *seeking, and helping students seek, connections to previous and developing knowledge;*
- *guiding individual, small-group, and whole class work.*

Mathematical content

The need for curriculum knowledge is an ongoing one which arises when new topics are introduced into a course or when teachers lack an adequate mathematical background. Ten documents stressed curriculum change and the need for more subject knowledge, in particular:

- statistics were mentioned in nine documents,
- an increased emphasis on estimation and on an alertness to the reasonableness of results were expressed in six documents,

- basic skills were mentioned in four documents,
- operations research was the only entirely new topic, but it arose in two documents only.

Three reports expressed concern about teachers' mathematical background and about the shortage of mathematics teachers and falling rolls that could have an adverse effect on the quality of mathematics teaching. One of these, Mathematics counts (D 48) highlighted the possibility that with falling rolls in secondary schools and consequent reductions in staffing, there may be an increase in pressure to have mathematics teaching undertaken by teachers for whom mathematics did not form a significant part of their initial training.

Mathematical processes

The documents indicated that the processes of mathematics (problem solving, modelling, reasoning, communicating, making connections and using tools) and the way that teachers are being encouraged to look at the subject warranted more attention than the content of the subject.

- problem solving

The need for problem solving was expressed in ten reports. If problem solving is considered to include open-ended investigations then fourteen expressed this need. In this context it is assumed that problem-solving is referring to solving non-routine problems.

- modelling

Traditionally, applications of mathematics have been taught at the end of a unit of work so it is perhaps not surprising that fifteen of the reports mentioned the need to have more applications throughout the programme. The term modelling refers to the use of mathematics to model real-life situations. The reports indicated that modelling should be used as an approach into and through a topic, rather than as an add-on if time permits. The two NZ syllabuses, one teachers guide, and one of the American reports stressed mathematical modelling.

- reasoning

Traditionally Euclidean geometry was taught for its stress on logic as well as the geometrical ideas it introduces, but as part of the "new maths" reform Euclidean geometry was replaced with a more informal approach using transformations. Logical reasoning, however, is still one of the cornerstones of mathematical thinking and five of the documents suggested that reasoning, logic, and proof are areas needing attention.

- communicating The syllabuses and teachers guides contain phrases such as,

"mathematics is a language by means of which numerical and geometrical properties and patterns are actively explored, communicated, and explained",
"use diagrams, graphs, and symbols appropriately", and
"provide ample opportunity to explain, discuss, and communicate"

These phrases highlight the need to use communication both in the learning of mathematics and working in mathematics.

Fourteen of the mathematics-specific documents indicated that aspects of communication needing attention were discussion (between teachers and students and among students), explanations, reading, writing, listening, reflecting, language across the curriculum, reference materials, symbols, numbers, algebraic expressions, graphs and diagrams.

- making connections In mathematics education it is considered desirable to make connections with the aims of general education, to link topics within mathematics, and to connect the ideas in mathematics to other school subjects, further learning, history, culture, and everyday life.

For some this is viewed as learning mathematics in a meaningful context, for others it is seen as part of making mathematics relevant, while for others it is seen as part of helping students make sense of their world rather than compartmentalizing their mathematical knowledge. The documents stressed the need for cross-curriculum connections (15); relevance (10); relatedness to everyday life (8); future life (study and work) (5); historical/cultural connections (4); connections within mathematics (4); and thematic connections (3).

- using tools The role of calculators, computers and other appropriate technology in the teaching and learning of mathematics is growing and calculators with graphical presentation and symbol manipulation facilities are now common. Twenty-six of the documents referred to calculators and computers directly or as technology.

The UK document *Will mathematics count* (D 47, p.29) summed up the influence of this technology.

> *The introduction of computers into mathematics classrooms will affect the mathematics curriculum in a number of ways. In particular, there are implications for:*
> - *the content of the mathematics curriculum, the approach adopted by teachers, and pupils' attitudes towards mathematics;*
> - *the balance of importance between topics within the mathematics curriculum;*
> - *the order in which mathematical ideas are introduced;*
> - *the way in which ideas are presented and approached;*
> - *the extent to which the mathematics curriculum is integrated with that of other subjects;*
> - *the organization of the curriculum;*
> - *the ways in which mathematics is assessed.*

Learning

Just as important as the content and the processes to be learned by students is an understanding of how it is to be learned and therefore what learning activities and teaching methods the teacher should use. Only five documents mentioned the need to understand learning theory, and two of these suggested that the emphasis should be on learning rather than teaching. The general concern was on moving from transmission teaching to using a variety of teaching strategies.

The USA report *Everybody counts* (D 52) sums up the concern about transmission teaching at a time when research in learning suggests that a constructivist approach would be more appropriate.

> *Research on learning shows that most students cannot learn effectively by only listening and imitating; yet most teachers teach mathematics just that way. Most teachers teach as they were taught, not as they were taught to teach. Research in learning shows that students actually construct their own understanding based on new experiences that enlarge the 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. Much of the failure in school mathematics is due*

to a tradition of teaching that is inappropriate to the way most students learn (p.22).

... in reality, no-one can teach mathematics. Effective teachers are those who can stimulate students to learn mathematics. Educational research offers compelling evidence that students learn mathematics well only when they construct their own mathematical understanding. To understand what they learn, they must enact for themselves verbs that permeate the mathematics curriculum; "examine," "represent," "transform," "solve," "apply," "prove," "communicate." This happens most readily when students work in groups, engage in discussion, make presentations, and in other ways take charge of their own learning (p.58).

The UK report *Mathematics counts* (D 48, p.71) in its frequently quoted paragraph 243 addresses the issue of a variety of teaching methods but does not mention learning.

mathematics teaching at all levels should include opportunities for

- *exposition by the teacher;*
- *discussion between teacher and pupils and between pupils themselves;*
- *appropriate practical work;*
- *consolidation and practice of fundamental skills and routines;*
- *problem solving, including the application of mathematics to everyday situations;*
- *investigational work.*

While paragraph 243 overlaps with the comments on the mathematical processes it implies that methodology change should reflect this new way of looking at the subject.

Sixteen of the reports made general comments about teaching and the need for a variety of methods, learning activities and resources. Twenty-nine included a number of specific concerns:

i Build on background, prior knowledge and interests of students; integrate new experiences into their existing knowledge; student-centred programmes;

ii Involve students in planning, allowing choice; provide motivation

iii Ensure enjoyment and success; raise expectations;

iv Provide opportunities for independent, cooperative and whole class work; develop strategies for mixed ability classes;

v Develop research and study skills;

vi Develop flexibility; perseverance; independence of thought; cooperation; reflection; survival skills; risk taking;

vii Develop a learning environment that uses a variety of localities including the outdoors; use local activities and resources;

viii Make use of themes; games and puzzles; visual imagery (displays, exhibits, and posters); library research; class project; exploring; practical activities including concrete material & equipment; projects; open-ended and creative tasks; stories; oral work (seminars); interactive approaches; alternative algorithms; readiness; classroom management; maintenance; and homework.

ix Use cooperative learning.

Assessment

Assessment has been a concern in education for some time with the most obvious concern in high schools being the assessment that is required for school leavers and external awards. Two principles concerning such assessment were stated in the Cockcroft report (D 48),

> *The first is that the examination papers and other methods of assessment which are used should be such that they enable candidates to demonstrate what they do know rather than what they do not know. The second is that the examinations should not undermine the confidence of those who attempt them.*

Twenty of the reports expressed general concerns about assessment and the need for professional development to broaden the range of methods teachers used. Many specific areas were identified where development work was needed, including:

i recognizing the influence assessment has on teaching and improving the assessment of written tasks (essays etc), oral tasks (seminars and presentations), practical work, projects and investigations;

ii developing methods of assessment that include formative as well as summative assessment, together with informal evaluation, and self assessment;

iii assessing for national awards, in particular internal assessment and assessment based on national standards;

iv assessing the mathematical processes
- problem solving,
- connections (contexts),
- communication (talking, discussing, questioning describing, explaining, prompting, probing, focussing, recording, instructing (directing), narrating, arguing, speculating, and
- technology (accepting the role of calculators and computers);

v assessing attitudes, and personal skills including group work (social interaction, awareness of problem, working on task, attitudes, communication);

vi reporting and using class and student profiles;

vii assessing staff and evaluating teaching programmes.

Equity

Related to both curriculum and school development were major concerns about equity and the need for professional development to address these issues. Twenty-eight of the reports documented general or specific concerns about equity issues in the mathematics curriculum. These referred to gender (13 documents), ethnicity and culture (18 documents), intellectual ability (9 documents), and other issues (11 documents).

Anderson (1989, in D 41) cited Gilligan (1982), Buerk (1985), and Burton (1987) as three authors who raise important issues related to different styles of reasoning, gender and mathematics. They postulated distinct masculine and feminine styles of reasoning that suggest the use of contextual approaches rather than the traditional logical approach.

Ethnicity issues included concerns about the problems of staffing and resourcing bicultural and bilingual classes, preserving the language and culture of Maori and Pacific Island students, improving achievement of Maori students, honouring the Treaty of Waitangi, and teaching when English is a second language.

Factors relating to intellectual ability included extending able students, helping the less able, providing remedial work where appropriate, and handling the wide ability range in typical unstreamed classes.

The other main concerns were related to helping students achieve their potential when they are from different backgrounds, different socio-economic classes, different geographic regions (rural/urban) and when they are disabled, physically handicapped, have special needs, or suffer from maths anxiety.

School

Components of school development concerned with areas not related specifically to mathematics but affecting mathematics teachers were mentioned in twenty-four of the documents. These concerned aims, management, guidance, and consultation. The development of a school's general aims and philosophy was mentioned in four documents.

Another topic necessary for professional development was the development of management skills at both the middle and senior level. Concerns with aspects of management that need attention were mentioned in twelve of the documents. These skills might be more relevant to the senior mathematics teachers than to the younger ones. Some were general management skills (planning, research, decision-making, financial management, time management, resource management); some were to do with curriculum (in particular scheme writing); and the others were to do with personnel management (job descriptions, training, team management, retaining staff, delegating, sharing, interviewing, chairing, consulting and supporting).

Student guidance was seen as an area of concern that affected all teachers and this offers another focus for professional development activities. The *Baseline Survey* (D 35) made three important points, it recognized that:

i a need exists for students to establish a personal value system,
ii most staff members are part of a guidance network, and
iii an important part of the guidance network was the form teacher.

The need for assistance in this guidance area included student behaviour (discipline and control), and also aspects of developing student autonomy, in particular finding student needs, helping them develop responsibility and decision making skills, and having them involved in curriculum planning and sharing responsibility for the teaching and learning outcomes.

Seventeen reports emphasized the need to have good communication channels with the community and the need for teachers to develop consultative skills. Some comments were general, others related to:

- community participation, views and expectations
- consulting with Maori and Pacific Island parents
- consulting between schools (clusters of schools and between primary and secondary schools).

Personal growth

Three main areas of personal growth emerged as a needing attention in professional development programmes—personal skills, preparing for changing roles in teaching, induction and supervision.

Six documents identified the personal skills that some teachers need help in developing. These included:

i personal relationships
ii communication (listening, sensitivity, assertiveness, cooperation)
iii group skills (facilitating, conflict resolution, networking)
iv supporting skills (valuing, counselling)
v cultural awareness
vi handling stress
vii extra curriculum activities.

Aspects of career planning were discussed in 13 of the documents. These included preparation for responsibility (including specifically responsibility for administration, curriculum, guidance, and professional development) and planning for retirement.

The *Starter Kit for the Induction of New Teachers* (D 40) obviously had the most to say about induction and gave details concerning areas needing attention. Induction of new teachers was also referred to in nine other documents. The *Review of Teacher Training* (D 36, p.73) extended induction to teachers with some experience. It recommended

> *that teachers returning to the service or moving into unfamiliar situations receive adequate in-service support.*

Other reports recommended induction for all staff newly appointed to the school, assistance for staff supervising teacher trainees, guidance with teacher registration, and help for staff assisting teachers who are causing concern.

10.5 Types of development activities

Many reports referred to professional development without indicating the form that it might take but some were more specific. The forms of development fell into three groups: regional activities, school-based activities, and individually initiated activities.

The Cockcroft report (D 48) referred to the importance of different types of courses, the need for spaced learning, and the need with shorter courses to ensure that follow-up occurs.

Regional

Professional development activities organized on a regional basis (national, district or local) were mentioned in ten reports and methods of delivery that were suggested included:

i in-service courses which could involve experts and specialists and could vary from one day (a teacher-only day) to longer periods such as 3 days or a week (perhaps residential) or one day a week for an extended period such as ten weeks;
ii local teachers' centres;
iii local curriculum initiatives;
iv visits to classrooms in other schools;
v examination panels for national awards;
vi networks

School-based

A similar summary of school-based training includes the following :methods:

- school based work together with sharing amongst other teachers
- planning together, trial, and feedback
- curriculum and resource development
- teacher as researcher
- visits to other classrooms (and other schools)
- course (20 days spread over the year)
- training the trainers (HODs advisers, TC staff)
- reading and reflection.

The school-based activities suggested by 15 documents included

i department meetings;
ii in-service courses similar to regional in-service courses;
iii school curriculum and/or resource initiatives including workshops (involving planning, trialling, and reporting back);

iv collegial support, visiting, sharing, cooperating, observing and constructively criticizing;
v advisers;
vi statutory departmental assessment (inspectors);
vii self evaluation;
viii observation & feedback (action research or professional development cycle);
ix informal training;
x delegation.

Individually initiated

Professional development activities that are individually initiated were suggested in twelve reports. They included

i personal reflection;
ii personal reading (library, professional journals, teacher guides);
iii membership of professional, subject and teacher associations ;
iv leave (study, refresher, sabbatical, and overseas);
v study (university, advanced study for teachers, correspondence);
vi action research (local level);
vii exchanges (overseas and with teachers colleges).

General

The *Guidelines for Consultants and Curriculum Leaders* (D 53, p.12) advised that

> *It may not always be wise to match in-service education to expressed teacher needs, as this may service the existing situation rather than stimulate change.*

This is relevant because the two forms of development are:

i quality control which improves efficiency and effectiveness of present strategies
ii design solutions which alter the system organization (e.g. syllabus change).

This same document (D 53) was the one that systematically looked at a range of different courses. These were mainly those that required consultant assistance. The list included:

i structured courses (say 10 weeks)
ii sandwich courses
iii in-school intensive courses
iv postal model (exemplary material, teacher guides, newsletters)

v peer tutoring

vi activity documentation (resource or strategy development).

One document, the Cockcroft report (D 48, p.228) suggested that,

> *More use should be made of the educational press both to disseminate the results of specific research projects and also to review and interpret for teachers the state of research on different topics.*

The Education Review Office's publication (D 16) suggested that most responses (regarding methods of delivery) were determined by prior experience that was successful .This reinforced the researcher's view that the reports (except for D 53) were all suggesting 'more of the same' rather than trying to analyse methods of development or try to find new methods.

10.6 Influencing factors

Mathematics Teaching: Making Changes (D 41, p.1-21) speaking about the process of change, says,

> *Change is more likely when there is a clear, well-understood process where each step contributes to solving the problem and leading towards the desired outcomes. The suggested steps in the process are:*
>
> - *identify problems to be solved*
> - *choose one problem to work on*
> - *describe the problem (evidence that it exists)*
> - *define the goals (what it would be like without the problem)*
> - *gain support (who will take the actions)*
> - *minimize difficulties*
> - *monitor progress*
> - *look back and review.*

This emphasizes the need to have the teachers involved in the planning, have well defined outcomes and processes, and provide support and time. Other documents made similar remarks and the earlier categories of influences (time, resources, feelings and support, and others) needed to be extended to include more about the organization and processes.

Time	The need for adequate time for professional development activities was stressed in three documents. It includes time to consider, reflect, and trial material, and time for activities to be ongoing and to allow for follow-up. This need for activities to take place over an extended period of time seems to be a recognition that no 'quick fix' solutions exist. It was suggested that ideally a new initiative should follow a successful change but people should have had time to adjust to the previous changes.
Resources	While financial resources that enable one to purchase time and professional assistance were the main resources that were seen as needed, three documents spoke more directly about the availability of trained trainers (advisers) and one spoke about the need for exemplary classroom resources. On the other side shortage of finance, resources, and sometimes suitable buildings (teacher centres) were seen as impediments to development.
Feelings and support	The need for participating teachers to feel a sense of ownership of development, to be supported and encouraged both in planning and in the later stages, and to have this support from colleagues and the school administration, were stressed in four documents that discussed the process of change. Ownership and trust only develop slowly and this also needs to be acknowledged. One document (D 53) suggested that projects should involve groups of teachers rather than individuals from a school and that the services of a consultant and/or a critical friend are useful in projects.
Organization	Area in-service committees were mentioned in one report as being a useful factor in the organization of professional development activities while five other documents made it clear that all teachers should be involved in the planning and must work collaboratively to ensure success, in particular when they are going to be affected by the changes. This was taken up strongly in one report (D 53) which insisted that professional development activities must address issues of concern recognized by the teachers themselves and that perhaps a needs-assessment activity was needed. Another report (D 41) stressed

the importance of activities resulting from applying accepted policies rather than from personal directives of administrators and that the people affected must be able to see the expected gains.

Two documents said that any retraining must take place as close as possible to the teachers' own working environment, that is, either in or near to their workplace.

Leadership was recognized as being important at three levels - school (HOD and principal), district and national. At the same time it was made clear that the best leadership style was one where convenors lead by facilitating, not by defining tasks.

Two impediments that occur in some schools were identified by two reports, namely the difficulty caused by staff driving school buses in rural areas which means they are not available for meetings after school, and the problem of getting quality relief teachers.

Process

The importance of modelling good teaching practice is stressed in *Everybody counts* (D 52, p.65).

> *Since teachers teach much as they were taught, university courses for prospective teachers must exemplify the highest standards for instruction. ... Prospective teachers should learn mathematics in a manner that encourages active engagement with mathematical ideas.*

Five reports commented about the process for professional development activities - it was desirable that all participants understood the process of change and the proposed outcomes; that they understood how students and teachers "construct" ideas and that this theory be modelled; and that many opportunities for sharing as well as reflection and feedback were provided.

Other influences

A number of other influences were mentioned that are relevant.
With respect to who gets invited to participate, or organizes themselves to attend professional development activities, one report (D 53) claimed that traditionally most course participants (invited or otherwise) were probably those that least needed the course.

Teachers in a school will be at different career stages and their propensity to use professional development activities for different pruposes caused D 53 to categorize teachers as omnivores, active consumers, passive consumers, entrenched teachers and withdrawn individuals. These labels highlight the different attitudes and responses that teachers will exhibit when considering professional development, and the need for planners to cater for a broad range of interests.

Everybody counts (D 52).said that public concern is a necessary, but by no means sufficient, condition for meaningful educational change, and that

> *effective change requires a great deal from the public:*
> • *Conviction of the need for change;*
> • *Consensus on high-quality mathematics education for everyone;*
> • *Scepticism of "quick fixes" and simplistic solutions;*
> • *Awareness of the general nature of needed changes;*
> • *Support for investment of necessary resources;*
> • *Recognition of the need for continuing leadership at the national level* (p.80).

The *Baseline Survey* (D 35) suggested that examinations, community standards and expectations, and the mass media were sometimes negative factors. The report went on to say that other factors that are sometimes identified as impediments were only minor ones. These included parents, pupils, senior staff, junior staff, PPTA policies, Department of Education policies, manuals, course regulations, competition from neighbouring state schools, demands of tertiary institutions, contributing primary schools, and zoning restrictions.

Ideas

One document suggested that ideas from elsewhere (that is, other than directly from the teachers) can be viable and cost-effective ways of beginning change and the *Baseline Survey* (D 35) categorized the sources of ideas and their importance.

(i) major	staff (principals and teachers)
	teachers college staff
(ii) next	books and professional journals
	inspectors and advisers
	associations (subject and principals)
	students

	councils
	curriculum development division
	PTA/PPTA
(iii) minimal	other schools
	visiting speakers.

(derived from D.35, p 298)

10.7 Conclusions

In general these documents were wanting similar professional development to that being requested by teachers and educators. They seemed more concerned with outcomes rather than establishing a development process, and in their curriculum statements the need became obvious to separate the content and the mathematical processes (what mathematicians know and what they do).

With the exception of a small number of the reports, the comments on methods of delivery and influencing factors seemed to be based entirely on the common experience of the writers—the comments therefore were based on present practice rather than possibilities, and were suggesting more of the same rather than an analysis of needs and methods, and alternative approaches. Only one of the documents (D 53) discussed the process of development in detail.

Chapter 11 A SYNTHESIS OF VIEWS

11.0 Contents

11.1	Introduction	160
11.2	Professional development requirement	160
11.3	Types of development activities	162
11.4	Influencing factors	164
11.5	Some comments	165
11.6	Some conclusions	166

11.1 Introduction

The purpose of this chapter is to synthesize the perceived views about professional development needs from the three sources—teachers, mathematics educators and policy documents (chapters 8, 9 and 10); to evaluate this synthesis against the literature review, and to begin to answer the research questions.

The teachers, mathematics educators and policy documents all agreed that professional development should occur for all mathematics teachers; some emphasized this while others took it as axiomatic.

In addressing the first two of the research questions—what are the professional development needs of high school mathematics teachers? and, how might these needs best be met?—the data in the last three chapters were categorized under the three headings, requirements, types of activities, and influencing factors. The next three sections of this chapter consider these categories in turn, bringing the data from the three sources together and showing how each contributes to the broader picture.

11.2 Professional development requirements

The content of development activities perceived by teachers, mathematics educators and writers of policy documents is summarized in table 11a. A tick (√) means that at least one of the responses mentioned this particular need.

The subheadings could be expanded. For example, teaching methods included more child-centred, group work, catering for individuals, classroom management, flexibility, motivation, communication and discussion, lesson planning, questioning, thematic teaching, practical work, cooperative learning, problem solving, and so on. While some

of these details will be relevant to particular schools or departments, the intention with the table is to show the general picture and provide an overview.

Table 11a Professional development requirements

Content	Teachers	Mathematics Educators	Policy Documents
School Needs			
Planning/Policy	√		√
School effectiveness	√		
Management concerns	√		√
Student guidance			√
Equity			
Abilities and mainstreaming	√	√	√
Gender	√	√	√
Bilingual	√	√	√
Rural/urban, socio-ec class			√
Maths anxiety			√
Broader curriculum focus		√	
Negative student attitudes		√	
Communication, consultation			√
People Needs			
Induction	√		√
Induction in new jobs	√		
Heads of departments		√	
Training the trainers			√
Supervision			√
Untrained teachers		√	
Non-specialist teachers		√	√
Personal growth	√		√
Career Planning	√		√
Curriculum needs			
Teaching methods	√	√	√
Learning theory		√	√
Mathematical processes	√	√	√
New content	√		√
Inappropriate content		√	√
Misuse of resources		√	
Assessment		√	√
Bilingual (Maths & Te Reo)	√		
Calculators	√		√
Computers	√		√

The three main headings are the same as those in the literature. The gaps on the table are an indication of the different focus that the three sources have. The lack of any mention of assessment by teachers is probably because of the timing of the interviews; after the new curriculum was distributed and when the New Zealand Qualification

Authority started to influence the school curriculum, teachers were asking for assistance. A notable omission in the table is concern about learning theory by teachers. The literature emphasizes the importance of an understanding of the underlying theory if change is likely to be successful, yet teachers were only concerned about teaching. Another omission was concern about the nature of mathematics. This emerged from the literature and would provide an underpinning for the mathematical processes and the use of calculators and computers, yet it was not mentioned by any of the three sources.

It is probable that the omission of these two important theoretical bases reflects the fact that professional development in the past has been focussed on imposed changes and has not been seen as an ongoing professional growth process. A change in focus to ongoing development would not automatically lead to a deeper theoretical underpinning but if more time was spent on coming to terms with the development process then this need would be expected to emerge.

Some omissions, in particular from the mathematics educators, exist because of the way the data was collected. A questionnaire was used that asked the educators to note their concerns, whereas the interviews with teachers were able to probe in more depth and ask about things that had not immediately occurred to the teachers. The policy documents had fewer omissions but many of the needs listed by them stemmed from areas of change and therefore by implication areas for professional development rather than being directly linked with professional development.

11.3 Types of development activities

The range of development activities is shown in table 11b. Again, subheadings could have been elaborated. The range of activities reflects what has traditionally been available. In the past many of these options were provided by agencies outside the school and most of the financial implications did not impinge directly on schools. The range matches, to a large degree, the types of development activities identified in the literature and listed in table 5c (p.53). Where the literature differs is in its emphasis. Much more importance is put on in-school development in the literature and while this was discussed by the three sources, the emphasis was still largely on initiatives (meetings and courses)

organized by outside groups, held outside the school, and bringing together teachers from a number of schools.

Table 11b Types of development activities

Types of development activity	Teachers	Mathematics Educators	Policy Documents
In-school			
Meetings (staff, dept., etc)	√	√	√
Sharing & visiting classrooms	√	√	√
Development			
curriculum (schemes etc)		√	√
assessment			
resources			√
Induction programmes	√	√	√
Teacher-only in-service days	√	√	√
Outside expertise	√		√
Action research	√		√
Observation	√		√
Mentors	√		
Advisers	√		√
Resources	√		√
Job delegation			√
Assessment by inspectors			√
Between schools			
Visiting other classrooms	√		√
Meetings (one-off and ongoing)	√	√	√
Residential courses (Ministry)	√	√	√
Jumbo days	√		
Examination marking	√		√
Teachers centres			√
Local curriculum initiatives			√
Teacher exchanges			√
Individually initiated			
Reading and reflection	√		√
Courses and meetings			
Teacher refresher courses	√	√	
Maths assns & networks	√	√	√
Conferences	√	√	
Study	√	√	√
Life experiences			
Parenting	√		
Overseas travel	√		

Another difference was that the literature viewed meetings and short courses as a component of bigger development programmes with follow-up occurring within the school; the teachers on the other hand, tended to see each activity as discrete. Thus a need emerges to ensure that professional development programmes are more cohesive and if a

teacher attends a conference or meeting to consider new ideas then considerable follow-up and support will be needed in school to ensure that the benefits of the meeting accrue to the school.

The question of responsibility for development was not so clear cut, but generally all three sources saw a need for responsibility to be shared at four levels—Individual, school, local/regional and national.

11.4 Influencing factors

The factors that influence development either positively or negatively that were perceived as important by the three groups are summarized in table 11c. The factors noted from the three sources contribute to a general view of what is believed to be important and were very similar to those that emerged in the literature.

Table 11c Influencing factors

Influencing Factors	Teachers	Mathematics Educators	Policy Documents
Time			
Time for meetings etc	√	√	√
Spread over time	√	√	√
Resources			
Finance	√	√	√
Study leave	√		√
Advisers			√
Exemplary class material			√
Feelings and support			
Critical number	√		√
Support	√	√	√
Report back & follow-up	√		√
Ownership of change		√	√
Understanding change process		√	
Leadership			
Head of department	√		√
Principal			√
District and national			√
Entrenched views	√		
Discrimination	√		√
Embarrassment	√		
Others			
Rural schools	√		
Improved communication	√		√
Workshops	√		
Needs analysis	√		√

The factor that was most emphasized was finance, since it was assumed that time and other resources could be purchased with money. The other factor that was mentioned by all three was support. These factors suggest that there is a need for considerable effort in development planning to modify activities to incorporate the positive influences and minimize the negative ones.

11.5 Some comments

In the three tables (11a, 11b and 11c) the three columns are not independent since they represent the views of the same or similar people in different roles. The mathematics educators have been teachers, and the policy documents were written with considerable input from past and present teachers.

When writing policy documents the authors usually have time to reflect on the issues. This explains why the policy documents covered more points than the teachers who focussed on their own needs. The mathematics educators were mainly concerned with the narrower focus—mathematics education. Although the contents of the documents were to be considered by teachers, the process of development was the focus in only five of the fifty-three (D15, D24, D40, D49, D53).

About 80% of the policy documents were from New Zealand and generally they were not based directly on research done here; in many instances they were based on ideas from overseas . The findings from the literature review were mainly from overseas and were derived more directly from research. The conclusions from the policy documents and from the literature have many similarities but the literature, with its direct focus on professional development is much more detailed.

The concerns and suggestions are firmly rooted in experience. The teachers were reflecting on their experiences, the mathematics educators have all been teachers and more recently have been organizing development activities, and the policy documents generally result from the input of experienced teachers and educators. Even an unusual suggestion such as the use of sustained silent reading periods for professional reading reflected something that one person had tried. This data reflect what has been rather than what could be, and the responses to questions about what development should be provided suggested

more of the same rather than anything new. This emphasizes the importance of prior experiences which fits with the constructivist view of learning for people of all ages.

11.6 Some conclusions

The initial research questions were

1 What are the professional development needs of high school mathematics teachers?
2 How might these needs best be met?
3 What model(s) for development would be appropriate?
4 What influences affect school-based professional development?
5 Can a teachers guide, incorporating the findings from question 2, help schools with the professional development of mathematics teachers?

The professional development needs have been identified by the literature and from the three sources of data as being very varied, focussing on aspects of the subject, the school and the individual, and largely dependent on the individuals and their situations. One finding from the literature that did not emerge strongly in the data collection yet is very important if coherent development is to be planned, is the need to have a theoretical underpinning,

i to understand the process of development,
ii to understand how people learn, and
iii to appreciate the nature of mathematics.

In learning one starts where the learner is but in moving forward it is important to introduce and address these three important issues.

The main finding on how these needs might best be met is by an ongoing programme based on teacher growth rather than on imposed change or remediation of deficits. While the data collection focussed mainly on discrete activities (meetings, visits, and courses that help by introducing new ideas and informing the discretion of participants) the literature emphasizes the broader process and views these activities as components of it. Thus, to best meet the needs of teachers, there is a need to help them build an understanding of the development process so that discrete activities can be integrated into it. This understanding of the process will also help teachers decide on the appropriateness of development models.

A range of models for development was identified in the literature but they were not mentioned in the data collection where development focussed on specific activities. The most significant findings about models were to have a model:

i that incorporates a number of components to ensure that change actually occurs (see tables 5a and 5b, pp.46–47), and

ii which is controlled by the participants and provides for ongoing development.

For pragmatic reasons such as finance and time, and for theoretical reasons such as the need for development to be located close to one's work, to relate to one's situation, and to be continuous, a mainly in-school model for development is likely to be the most appropriate.

A consideration of such in-school development and the usefulness of teachers guides to answer the last two research questions leads to the final phase of data collection described in the next part of this study.

PART D **SCHOOL-BASED DEVELOPMENT**

Chapter 12	Organization of school-based development	169
Chapter 13	Leadership for in-school development	180
Chapter 14	Teachers guides	186

In this fourth part of the research data were collected from a wider sample of heads of mathematics departments. This was done because in chapter seven the senior teachers were identified as contributing more because of their range of experience, and in the literature review heads of department were identified as important for in-school development.

The focus for this section is on in-school development because this is the most likely way forward from the analysis of the data (part C) and the literature review (part B).

The first chapter of part D (chapter 12) considers some data about organizational aspects for in-school development , while the next (chapter 13) looks at development in terms of data on leadership. Both these chapters reflect the New Zealand setting. In comparison to the broader view in the literature review, the New Zealand perspective was more limited.

Chapter 14 is concerned with the development and evaluation of a draft teachers guide about professional development. This brought together important views from the literature in a form that might be appropriate for New Zealand schools and aimed to help teachers consider alternative ideas about professional development. High school mathematics teachers have been accustomed to teacher guides and when new developments occur they usually request one.

Chapter 12 ORGANIZATION OF SCHOOL-BASED DEVELOPMENT

12.0 Contents

12.1 Methodology 169
12.2 Approaches used in schools 171
12.3 Planning 174
12.4 Appraisal schemes 176
12.5 Department meetings 177
12.6 Summary 179

12.1 Methodology

Heads of department

During the first part of this study, staff from six schools were interviewed (chapter 8). From these interviews it became evident that senior teachers had a broader experience to draw upon, and from the literature heads of department were identified as key people in professional development. Rather than continuing to interview all the teachers in the six schools, it was therefore decided to increase the number of schools to 14 and to interview only the heads of department. This group has been referred to as key-informants (Borg and Gall, 1989). The schools are listed in table 12a.

Table 12a Schools for heads of department interviews.

Locality	No	Schools	Approx roll	Maths teachers
University city	2	Fairfield College	1130	10
		Green Bay High School	680	7
Provincial city	1	Western Heights H.S.	1340	10
Provincial town (close to city)	4	Huntly College	550	6
		Morrinsville College	670	6
		Ngaruawahia H.S.	440	6
		Te Awamutu College	1030	10
Provincial town (remote from city)	4	Otorohanga College	470	5
		Te Kauwhata Coll, F1-7	370	6
		Thames High School	640	7
		Waihi College, F1-7	730	7
Remote rural district	3	Mangakino H.S., F1-7	220	4
		Reporoa College, F1-7	320	5
		Whangamata Area S.	500	6

The nine F3-7 schools, four F1-7 schools and one area school were reasonably representative of coeducational schools in the Waikato-Bay

of Plenty area (one is out of the region). Two other schools which were invited to join the research declined for good reasons.

The fourteen heads of department comprised four women and ten men. Two were newly appointed (within 12 months), three were on the point of changing schools or being promoted, another had been acting in a senior position between the two interviews, and one had been job sharing (this changed between interviews). The fourteen ranged widely in age, experience, training, enthusiasm, and the extent to which they sought to be involved in the professional lives of their colleagues.

Data collection and analysis

All fourteen heads of department were interviewed twice as part of this research between September 1992 and May 1993. Only one was not interviewed at her school. Six of them, from the schools in the earlier part of the research, had already been interviewed in 1991 so for them these constituted a second and third interview. The interviews were audio taped, transcribed, returned for correction, and then analyzed. The discussion foci for these interviews are in appendices D.1 and D.2 (pp.234-236).

During the analysis three main foci emerged. These are reported in three chapters:

i organization of development, especially in-school (this chapter),
ii leadership for in-school development (chapter 13), and
iii teachers guides (chapter 14).

With respect to organization of development, this chapter reports on
- approaches used in schools (courses, study, in-school, difficulties)
- planning (management plans, schemes, budgets, locus of control)
- appraisal schemes, and
- department meetings

Throughout chapters 12 to 14 quotations have been identified by a number and a letter (5b etc). The number refers to the interviewee, 1–3 were used for the city schools, 4–7 for provincial towns close to the city, 8–11 for other provincial towns, and 12–14 for remote rural schools (not in the order in table 12a). The letter refers to the interview, a for 1992 and b for 1993.

12.2 Approaches used in schools

The fourteen heads of department were invited to talk widely about professional development activities that had occurred in 1992 and were being planned for 1993. The range of responses focused on the three main strategies being used: courses, study, and in-school activities. The heads of department also discussed a number of related matters that affected development.

Courses

The main forms of development identified and made available to their staff were:

i one-day courses that are increasingly being advertised by in-service providers, including many commercial ones,

ii development activities offered by mathematics advisers and contracted consultants as part of the Ministry of Education achievement initiative,

iii teacher refresher courses, and

iv the NZAMT conference.

All the schools had been able to provide professional development through these approaches and all the requests from teachers to attend had been satisfied.

Not all teachers had attended these courses and half of the heads of department had misgivings about them which were similar to those of teachers reported in chapter 8. For example, one (12b) mentioned course overload and the need for extended support:

> *a professional development course which addresses all the issues of the new curriculum is thoroughly inappropriate, ... it gives too much information in one big hit. The best sense of curriculum development for professional development for us, would be to have a, say a half day course or a day course with an ongoing programme, very similar to the LTR courses, where you have to keep practising and you are given a specific skill each time to learn. You go back and practice and bring back your homework. In our experience that's by far the most efficient way of changing what we want to do and that's the easiest way for us to have professional development that sticks.*

Another (5b), commenting on what was offered by advisers and consultants, said

> *I am not impressed,*

and yet another (2a) felt that in-school work was valuable but added

> *I think the people in our department get a lot of stimulation from each other. I don't think any of them feel the need that I had when I was at my last school. ... sometimes I have to push them out the door to a course ... I don't think they actually feel the need to look outside the school. I don't think they feel that they are actually exhausting the resources that are in the school in terms of getting assistance.*

Study

The other major form of development activity outside the school was study. Half the heads of department reported that some members of their staffs were studying or intended to study. The study providers were the Correspondence School, colleges of education, and universities.

In-school

Four forms of in-school development were discussed:

i project-focused activities such as rewriting schemes, modularizing courses, and preparing achievement-based-assessment activities,
ii department meetings for professional development,
iii informal chats, and
iv professional reading.

Twelve schools involved staff in project-focused activities such as the development of schemes. In five of these schools the heads of department prepared the first drafts of the schemes so the staff activity would be at the fine-tuning stage. These five heads of department felt that their job was to do this administrative work and that this approach was an efficient way of producing a scheme. They did not think that writing schemes was part of professional development and were not aware of the need for their staffs to develop ownership of the scheme.

Ten schools had regular mathematics department meetings. The main focus of these varied from administration to development. Four of the schools used the meetings only for administration while six emphasized professional as well as administrative activities. Of these six, two did

most of their administration by memo and focused the meetings mainly on professional development. The professional development focus at meetings included the sharing of new ideas. It was cooperative and ongoing development rather than project-based activities driven by external authorities (see 12.5, p.177).

All the heads of department mentioned their availability for informal meetings and reported that they often talked to colleagues in the staff room. They all reported having an open-door policy and colleagues were always welcome. Only two heads of department indicated that they would systematically initiate this discussion with their staff and ensure that the focus moved from social to professional matters.

Professional reading for staff was seen as important by three heads of department (1b, 2a and 11a). This involved sharing professional papers, reading them (perhaps during sustained silent reading periods), and using them as a focus for discussion and a source of new ideas for department meetings.

Difficulties

Apart from costs the main problem mentioned was the quality and availability of teacher relief. Interviewee 9b comment was typical:

> *Now one real problem with in-service, is that when we are away, the classes really don't get taught adequately at all. And I have had people who had been reluctant to go away, because, firstly they prepare the work, but that's not such a major problem, but it doesn't get taught very well. It doesn't get taught at all, maybe someone sitting in front of the class knitting. So what I am saying here, is that it's all right to say ministry or PPTA or whoever to say, oh we pay day relief, it's excellent, the kids get looked after. But the reality is that often they don't. So teachers get torn two ways.*

One other concern was the perceived lack of interest by staff in professional development. Two heads of department (3b and 5b) suggested that staff were not keen, particularly when the activities were in people's own time. Others indicated a lack of interest displayed by teachers of other subjects who had been pressured to take one or two mathematics classes. An exception to this view came from a smaller

school where the head of department had initiated plans to upgrade the mathematical background of non-mathematics teachers.

12.3 Planning

Management plans

The extent of planning varied from school to school and had been in a state of change since the 1989 restructuring of educational administration. Five schools had school-wide management plans and the heads of department in these schools formulated departmental objectives within these. In another two schools the planning had started at departmental level. In three others the focus was on specific concerns but was not part of a coherent plan, while the other four heads of department claimed that they were not involved in any forward planning. Many of the heads of department described the planning as an imposed extra task and they described it as a 'hassle'; only two said it was important. None of them thought that it was important enough to involve their staffs; nor did they recognize it as an opportunity for planning development.

One head of department (9a) outlined the planning process:

> *I'm involved in developing a management plan for 1993, and this is typical of how we have upgraded for the last two or three years. ... I have to prepare my own department budget, I have to prepare a plan of professional development in-service that we would like within the maths department, and set priorities (defining objectives for our department).*

Schemes

All the schools had schemes and a number of them mentioned the need to make changes to implement the new curriculum and achievement-based assessment. Only one (4b), thought it was unimportant. He said that he had faith in the professionalism of the staff and commented:

> *All this nonsense about schools writing their schemes. To me it's an enormous waste of manpower, well person power.*

Budgets

Budgets for professional development were discussed. Ten of the fourteen thought these budgets were adequate while the other four were concerned that they were rather limited. In discussing these it seemed that refunding travel and accommodation costs (13a and 14a) and study fees (5a, 6a, 12a and 13a) was not as generous as people would have

liked but this was generally accepted in the context of 'that's how it's always been'. The acceptance of levels of budgets surprised the researcher. It seemed to be based on a number of factors:

i budgeting for professional development had only been in place for two years and in these years it was reasonably generous;

ii considerable development was being subsidized by Ministry contracts (although these would disappear in the future),

iii generally schools were reacting to development activities that were offered by outsiders; they were not yet initiating their own.

Since the interviews, in informal discussion with many heads of department, the view has been expressed that less and less money is being put into the development budget and it is no longer adequate.

Locus of control

The heads of department were asked whether they felt that the control of professional development for mathematics teachers should be based locally (in schools), regionally, or nationally (with the Ministry).

Only two schools indicated a preference for totally school-based development, two smaller schools preferred national control, and the others seemed to prefer to continue with the mix of options and guidance that operates at present.

In general the larger schools felt more confident about local control while the smaller schools favoured more direction from outside. This larger school view was summed up in interview 7b:

> *yes, our department certainly could. We've got all the expertise there to do it.... in our school we are very lucky ... because we've got people who are aware of maths, probably on a national scale, and particularly on a Waikato one, we've got it there, we'll deal with it. For a smaller school, or a school who ... never ever go to maths association or go to anything, they are going to have really big problems.*

On the other hand, interviewee 13b from a small school said:

> *I think you limit yourself being school based. You don't have the same contact with other schools that is necessary, especially in a small school. I definitely would like to see it regionally based. I think nationally based, and you had courses in say Wellington or Auckland, starts becoming very expensive on the budget of the*

school; somebody is going to not get the necessary professional development. I think regionally based would be the ideal solution.

Regional

Over half spoke of the valuable work of their local in-service committees that comprised representatives from local schools and, since the 1989 restructuring, was funded directly by the participating schools. They felt that through their involvement with these committees they were able to ensure that what they wanted was offered.

12.4 Appraisal schemes

Nine schools were in the process of developing a formal staff appraisal scheme that focused on professional development needs. Three others had informal needs appraisal systems and in the other two no attempt was made to systematically identify needs.

The discussion of a needs appraisal scheme seemed to reflect a management-by-objectives model within the schools and the remediation of teacher deficits rather than an ongoing growth model of development. The teachers were not so concerned about this focus but had been concerned that information gained from appraisal might be used in a performance review, and one head of department reported that the introduction of a scheme was causing problems.

Another head of department (6b) who was keen on an appraisal said:

What I also did during the year, which was one of the best things I've done for a long time, was I shouted myself (to) the Naenae College teacher appraisal professional course. And that was excellent, and it really made me focus in a lot more on ways that I could be looking at an appraisal system in our department and consequently on professional development.

Job-descriptions

Head of department job descriptions were mentioned in passing by some respondents and when probed they all said that professional development was in their job descriptions. They generally believed that giving information to staff about externally provided development activities satisfied this part of their job specifications.

12.5 Department meetings

In section 12.2 (p.171) department meetings were mentioned as one opportunity for in-school development although the absence of meetings in four schools and the total focus on administration in four others indicates that this opportunity was not being used to the extent it could. Of the six schools that did focus on professional development, three held meetings infrequently and only three schools had weekly department meetings for ongoing professional development.

The head of department (11b) in one of these three described the purpose of the meetings:

> *I use our maths department meetings mainly for the staff development. Our last one was last Tuesday week, and one of our teachers who had been on a course on statistics did some of those statistical exercises with us as a group .He didn't actually finish because it was only one lunch hour, so we will continue with his next one. So I don't actually run the maths department meetings, I like the staff to share ideas and so on.*

This head of department had previously spoken of the importance of doing things for the development of ownership in the implementation process, and in this quotation has demonstrated a valuing of follow-up, support and modelling of new ideas.

A head of department (12b), from a small school recognized similar needs and spoke of the difficulty with a small staff. She thought the solution might be to have:

> *regular meetings in school time for subject teachers from a number of schools to get together and share resources, ideas and encouragement.*

Another (7b) commented on the difficulty of time:

> *One of the problems is we just have not had enough time together as a department.*

and in looking for a solution decided:

> *... we have one full meeting a month and staff are voluntarily coming in at ten past eight every Thursday morning, to try and get some more time to sort things out, but we still feel we are way behind in the things we would like to do.*

A third (2a) organized a series of one-day department meetings at the end of the year when seniors were away to cope with the time problem. She recognized the inability to *sandwich* trial activities between these meetings in the way that would normally be desirable.

One head of department (5a) who had not yet organized meetings seemed unsure about how to do so effectively,

> *It's sort of something I feel a bit guilty about not doing, ... I would like to sort of start having regular maths meetings. But I would also like to have a firm idea of what you are going to do in them and also use them as some sort of means of staff development, you know, sort of talking about new ideas and new lesson plans and those sorts of things.*

Positive aspects

Two heads of department summarized their feelings about successful departments; their responses link with professional development. One (7b), whose department supplements their monthly meeting with a weekly Thursday morning session said,

> *Our department is a very strong department, partly because it's a very cooperative department; we all work together, we all help each other. And that really does give us a lot of strength.*

The other (1b), whose department had developed considerably between the two interviews, said,

> *Well people are much more confident about their own ability, and their ability to share. There's a really good feeling of comradeship there, and this year all the so-called mathematics department are all teaching a third form, ... and we are making a big thrust to 'hit' the 3rd form. And people are feeling very confident and very positive about what we are doing, ah, X and Y are doing lots.*

He went on to talk about the sources of new ideas,

> *I think what people would like ... is ... one-day courses, to give them a bit of a boost - what seems to be happening when we go to courses is ... we're pretty much up with the play, there are some ideas we haven't thought about, but it's not like a foreign language any more. In fact a lot of the time its like we're ... well not quite on the edge, but pretty close to being there.*

12.6 Summary

From the data gained by interviews (not by personal observation), the research indicates that with leadership, development does seem to occur. This suggests that by helping heads of department develop their leadership skills more development is likely to occur.

Professional development can be initiated and occur without the school providing assistance and support to the individual involved but is more likely to occur with support. One form of assistance is follow-up. Whether courses held outside the school are followed up, whether in-school professional development meetings are convened, whether professional reading is distributed, whether follow up and support activities follow the introduction of new ideas all seem to depend on the leadership within a department and this leadership is generally expected to be provided by heads of department. This needs to be addressed by heads of department, they should be providing assistance, support and follow up, or be organizing others to do so.

Difficulties being encountered included costs for development and a perceived lack of interest in development by some staff. These are likely to be minimized as a culture of ongoing growth and change develops within the department (and the school) but are unlikely to disappear completely. In the planning of development the cost factors need to be considered so that individuals are not having to bear too many direct or indirect costs, and the planning must take into account the perceived needs and interests of al the staff.

As leadership seems to be a critical factor in professional development, it is explored further with the fourteen heads of department in the next chapter.

Chapter 13 LEADERSHIP FOR IN-SCHOOL DEVELOPMENT

13.0 Contents

13.1 Introduction 180
13.2 Professional development for heads of department 180
13.3 What makes the difference? 181
13.4 Climate 183
13.5 Conclusions 184

13.1 Introduction

In the literature review (7.5, p.94) the role of the head of department emerged as important. In chapter 12 some aspects of management of in-school professional development were discussed and these pointed to the need for leadership which partially answers the fourth research question—what influences affect school-based professional development? In chapter 6 of the literature review leadership had also been identified as important (6.2, p.62) and had been seen as coming from others as well as the head of department. For in-school development the others included the principal, the professional development (or curriculum) coordinator, or some other teacher with delegated responsibility.

In terms of an ongoing development programme a facilitative style of leadership was seen as desirable (6.2, p.62) and within a secondary school mathematics department the head of department is the person whom staff expect to provide the leadership. From the interviews it appears that in some instances heads of department need assistance in developing leadership skills so that they can move from a deficit, remedial and imposed viewpoint on development to an ongoing growth model that builds on strengths. They need help to develop leadership skills so that instead of viewing their role in professional development as matching people with courses, they will initiate activities to help establish an ethos for growth within their departments.

13.2 Professional development for heads of department

In responding to the question about assistance for heads of department, seven of the fourteen heads of department mentioned heads of department courses (either within the school or regional courses). One (9b) suggested that courses might include a discussion of

duties of an HOD, how to be a good HOD, how to write a scheme, and how to run a department.

Another (3a) reported on an existing in-school inter-departmental scheme:

we run an HOD of large departments (meetings) and we have had one half day away. That was absolutely fantastic ... we had common concerns which none of us were aware of

and one other (7b) suggested that in-school, inter-department schemes would be a good solution.

Three mentioned handbooks for heads of department, one specifically spoke of the draft HOD manual from New Zealand (Department of Education, 1984a) and another of the handbook from England (Ashley et al., 1988). Two mentioned the value of an *apprenticeship* where they had worked closely with a head of department. Three could not describe what had helped them or might be needed to help a head of department improve their management of professional development tasks.

These comments suggest that assistance of some form is needed and it is likely that the problem is not peculiar to mathematics departments.

13.3 What makes the difference?

Differences of age, gender, years of experience, and enthusiasm are easy to document and obviously exist between fourteen heads of department. In talking with the interviewees a more critical leadership quality seemed to be how proactive they were, that is, their willingness to take initiatives rather than merely respond to pressures. An attempt was made to classify the fourteen on a proactive-reactive scale, to explore the differences between the types, and then to see if this provided an indication of who was providing leadership.

Proactive scale

To classify the heads of department on a proactive-reactive scale the criteria used were that being proactive included:

- a willingness to run departmental meetings,
- an involvement with in-service committees,
- a willingness to trial and to question new initiatives,
- the extent to which they viewed their work as problematic, and

- the way they went out to help colleagues compared with having an open-door policy where people would come to them for help.

The researcher assigned a 0, 1, 2 or 3 on each of these five factors, aggregated these values, and graphed the results. The process was subjective and the assignment of numbers was based on what people had said in their interviews. It provided one way of making sense of the data. The fourteen seemed to cluster into the five groups shown in figure 13a. (The minimum possible was a score of 0, the maximum 15, the heads of department ranged from 2 to 14)

The criteria were accepted as being linked with years of experience in teaching and/or as heads of department, as expectations of teachers and heads of department have changed considerably over the years.

Figure 13a Location of HODs on a proactive/reactive continuum



The sizes of the interviewees' schools was not linked to their position on the continuum. The four women were on the more proactive side although more research is needed before it is possible to say whether this is a gender difference or related to the length of their experience. They seemed, however, less threatened by change and by working cooperatively.

The more proactive people seemed to be those who were less satisfied with the status quo in their schools, were looking for improvement, and were enthusiastic and optimistic in approaching this task. This seemed to fit with the comments from one head of department (8b), reflecting on the heads of other departments from his school, who said,

> *School in-service, depends on ... the enthusiasm within certain departments. So there are a couple of departments that get into designing and running their own in-service courses, there's only a couple. I think Social Studies is one, Science is another. Science because they do not consider the outside providers ... up to scratch. Other departments just let things (be) either through lack of enthusiasm or over-work.*

Prior experience

The heads of department were questioned about the experiences that they had had under other heads of department and in other schools. The comments varied. Two (7b and 10b) recounted very positive experiences with good role models and 'apprenticeship' opportunities. The majority made very few positive comments about heads of department they had worked under, and one (14b), at the extreme, suggested that he had had no support, his head of department had shown no interest, and he could not remember any senior teacher ever visiting his classroom in the last 20 years.

Qualities

While heads of department were rather reluctant to talk about the qualities that made them different from others, some of the more proactive ones did disclose the qualities they identified in themselves. These included:

i cooperation, sharing and team building skills,
ii good communication skills,
iii facilitative skills,
iv openness,
v enthusiasm, and
vi enjoyment of mathematics and people.

These six qualities provide a possible starting point for professional development for heads of department.

13.4 Climate

The climate in schools has changed over the last few years. In the past teachers expected to be involved in developing curriculum and assumed the right and the responsibility to resist change if they thought it undesirable. The change process was usually spread over a number of years so they had time to come to terms with initiatives and a sense of urgency was not so prevalent. In the present situation there is fast-track restructuring of education, implementation by legislation of the achievement initiatives, and uncertainties created by different opinions about autonomy and assessment from the three competing bureaucracies in the educational sector (the ministry, the review office, and the qualifications authority).

Although changes were being forced on schools without consultation and teachers appeared to have no control but all the responsibility, there

was a general acceptance that things had to change and that having innovations imposed was not all bad. This suggested that heads of department did see their work as problematic and did identify to some extent with the proposed solutions. Only one of the heads of department had been directly involved in the development of the new curriculum. The others were aware of the changes although two did not realize the extent of them.

Within this climate of change two heads of department spoke of adjustment difficulties. One (10b) reported that

> *the administration is very much (aiming) to keep in the forefront of change, yet not to go hell for leather, like some schools have, and it's turning into a stressful time for staff. I think the boss is very mindful of ... the work loads and pressures and the need to tread carefully.*

Another (2b) reported that the principal had had to fight to establish a climate for change within the school , the board and the community.

The acceptance of change by the teachers in mathematics departments as reported by their heads of department was directly linked with the acceptance or otherwise by the heads of department and the more proactive heads of department viewed change as positive rather than as inevitable.

13.5 Conclusion

Leadership has been identified as an important influence on in-school development. The research data suggested that some heads of a mathematics department provide proactive leadership while others are merely reactive. Lack of professional development opportunities for heads of department was identified. providing such opportunities appears to be an important priority to enable heads of department to develop their skills to initiate more professional development within their schools.

The nature of in-school leadership development activities requires careful consideration. One interviewee who had experienced such opportunities reported that they are an effective method of breaking down the isolation that some heads of department feel. Such activities

would be expected to help change the school climate by providing support for development, and would help the heads of department build their leadership and development skills.

Successful heads of department need leadership skills and a focus for development activities. In the past the initial focus has often been provided by pressure of a new syllabus and supported by teachers guides. If heads of department become proactive then the focus should be on the establishment of an ethos for growth which would move development from the traditional deficit model to one of ongoing growth. As part of this development the heads of department are likely to need help in coming to understand the whole development process.

If principals wish to build an ethos of change and growth within their whole school, they could model the leadership expected from their heads of department by providing (or ensuring that someone provides) in-school leadership training. If the ethos for change is being built initially within a department (rather than the whole school) then assistance for the head may need to come from some other source. With this in mind and to assist heads of department plan professional development, a teachers guide was written for them. Chapter 14 reports on the development and the effectiveness of this guide.

Chapter 14 TEACHERS GUIDES

14.0 Contents

14.1 Introduction 186
14.2 Production of a guide on professional development 188
14.3 Methodology 189
14.4 Reactions to teacher guides 190
14.5 Responses to the professional development guide 191
14.6 Conclusions 194

14.1 Introduction

In the past decade a number of teacher guides, syllabuses, and other publications, have been issued to high schools to supplement texts (see table 14a). Most were linked to syllabus or prescription development, and although in a number of instances they were provided late, the requests from teachers at the time suggested that these were appreciated. Two of the guides (*Language and Learning*, and *Countering Sexism*) were to help development in particular ways not directly related to specific curriculum initiatives, while one other (*Discussion Starters*) and the two periodicals were intended to provide a general focus for development.

Table 14a Mathematics publications issued to high schools (1983-92)

Title	year	levels
Guides		
Language & Learning in Secondary School: Maths	1991	F3-7
Countering Sexism in Education	1989	all
Assessment Ideas in Mathematics	1988	F3-7
Maths with Statistics: Supplement	1988	F7
The Graphical Presentation of Data	1988	F3-7
Mathematics F 1-4: Introduction	1986	F1-4
Mathematics F 3&4: Ideas	1986	F3&4
Maths with Statistics	1986	F7
Maths with Calculus	1986	F7
Discussion Starters (Draft Edition)	1986	all
University Entrance Mathematics Guide Notes ...	1985	F6
The HOD Manual (Draft Edition)	1984	all
School Certificate Mathematics Guide Notes ...	1983	F5
Syllabuses		
Mathematics in the New Zealand Curriculum	1993	all
Draft Syllabus: Forms 5 to 7	1989	F5-7
Forms 1 to 4, Syllabus	1987	F1-4
Junior classes to S4, Syllabus	1985	J1-S4
Others (Periodicals)		
MATHSplus #1-4	1991-92	all
Mathsnews #11-22	1985-89	all

All these guides were intended to provide:

i professional reading for teacher development,
ii assistance for heads of department,
iii a component for individual study, and
iv a focus for departmental discussion.

With a new syllabus or examination prescription the more specific purposes of teachers guides were to:

i put the syllabus change into a broader perspective,
ii outline the depth to which topics should be studied,
iii suggest weightings for various sections of a course,
iv outline some teaching strategies relevant to new topics,
v give assistance with approaches to existing topics,
vi introduce applications, and
vii provide assistance with aspects of planning.

These purposes were identified by the writers without specific reference to the professional development process, but they do link with the provision of new ideas (theoretical ideas and teaching activities) that form one component of the development process.

Within a syllabus the focus was mainly content although each new curriculum document also attempted to move teaching styles in line with recent theories. In the past, changes to teaching were usually alluded to in the introductory section of a syllabus, and the detailed implications were provided in teachers guides where it was considered more appropriate to suggest alternative approaches. Usually no theoretical justification has been given, the apparent assumption being that teachers only want and need to know what to do.

These teachers guides were sent to all schools and virtually no organized teacher development focused on them. Indeed the guides have traditionally been prepared and sent out after the syllabuses have come into force and after at least the first round of development activities. The teachers guides were simply given to teachers. As one head of department (9b) said, *we've used them as reference points.*

14.2 Production of a guide on professional development

In the past, as a curriculum officer, the researcher had been centrally involved in the writing and production of 10 of the 19 publications listed in table 14a and had a peripheral involvement in a further three. It was therefore with some confidence that the task of producing a teachers guide about professional development was undertaken. The intended outcomes were that distributing it to heads of department and their staff would stimulate discussion on various aspects of professional development, and that this discussion might later lead to change being implemented.

The researcher was aware of Bolam's matrix (table 5a, p.46) in which new ideas constitute just one of the components needed for successful professional development. While a teachers guide could provide only this first component, it would be useful if the other components were provided by the school.

The literature review for this project (chapters 4–7) and the initial collection of data (chapters 8–10) provided the material for the guide. The main aims of the guide were to:

i make the issue of professional development problematic;

ii put the responsibility for personal change on the teachers but to show ways that schools can assist in planning for development;

iii provide a structure for planning for the complex process of change;

iv increase awareness of the importance of various components in effective development activities and to provide some details of how these components can be built in to a professional development programme;

v suggest alternative models for development that consider the issues of cost and effectiveness; and

v provide some ideas related to each component for consideration by teachers and planners.

The full text of this guide is in appendix E (pp.238–265).

The guide expanded on a cyclic problem-solving model which many schools were at least aware of. This was planned to allow the participants to take control even though, because of a new mathematics

curriculum (Ministry of Education, 1992b), they would also be facing imposed change. This planning to take control was a deliberate first step as pushing too far with the most effective form of professional development was expected to be threatening to the teachers and result in rejection. On the other hand, after teachers took on some of the ideas in this guide, it was assumed that they would probably then move to a teacher growth perspective.

The researcher accepted the view that professional reading was only one source of new ideas. He was also aware that while reading alternative texts and teacher guides is an appropriate form of professional reading, guides may not adequately consider teachers' prior views, may suggest approaches that conflict with teacher beliefs, and are unlikely to cause the teachers to change behaviours without other support mechanisms (Appleton, Hawe, Biddulph and Osborne, 1984). Thus, while guides appear cost-effective,

> *the need for interactive communication through in-service courses to support written materials may have to be accepted if the practice of teachers is to be influenced substantially*
> (Appleton, Hawe, Biddulph and Osborne, 1984, p.212).

The researcher believed, from previous experiences with guides being delivered late, that a lack of resources caused a slowing down in the change process and did not cause a halt. As one head of department (T 38) had reported in 8.4 (p.113), teachers guides were often used as occasional references and to check details rather than to stimulate significant changes.

14.3 Methodology

Approximately 100 copies of the draft edition of *Professional Development: designing programmes for high school mathematics teachers,* were produced. They included two response sheets (appendix E.24 and E.25, pp.266–267), one intended to be used after an initial reading, the other to be completed after planning for 1993 had finished.

The guides were handed to the heads of the mathematics department in the 14 schools (table 12a, p.169) at the time of the heads of department interviews (September to November, 1992) and they distributed them to

their colleagues. At the final round of interviews (February to May 1993) one of the discussion points was teachers guides in general and another focused on the professional development guide. Response sheets from teachers who had filled them in but not posted them were collected at this time.

Twenty-two of the initial response sheets and two follow up ones were received. This rate (22% and 2%) may have been influenced by the fact that they were issued at a busy time of the year and by the moratorium on curriculum activities put in place by the teacher unions. Working through heads of department rather than directly with teachers may have been another factor as responses were only returned from 9 of the 14 schools, and from 3 of these only heads of department responded.

The 24 responses were supplemented by comments elicited during the 14 final interviews but most of these were about teachers guides in general rather than the professional development guide.

The response sheets were analyzed by collecting together the responses to each question about the professional development guide. The responses were brief, due presumably to the limitation of a few lines provided in the response sheet. The interviews were audio taped, transcribed, returned for correction, and then on reading the responses were analyzed into categories. The interview data related to teachers guides in general were separated from those about the professional development guide and those about the specific guide were categorized with the response sheet data.

14.4 Reactions to teacher guides

When asked to consider teacher guides in general (rather than the professional development one), most heads of department focused on one or two that they remembered and then commented. One (13b) said,

> *If it's in front of them and they realize their worth, then they will get in to it. Often enough it just sits on the shelf not being used, which is unfortunate, because it is good value.*

Another (4a) said,

> *Initially the reaction is, oh good, and then after ... why did they do that, why shouldn't they, why didn't they do this? I tend to*

find their value diminishes as you get experienced, when you are actually teaching.

The comments from heads of department on general teachers guides seemed to range from one extreme to the other, specifically:

great, everyone needs them	9b
very useful, especially F7	4b, 6b, 7b
useful	12b
good for content	7b
helps with easy things but not with the hard parts	8b
some relevant points	13b
they're given out—that's it	10b
not used much, unless needed	11b

14.5 Responses to the professional development guide

In spite of the low rates of return for the two response sheets, the comments gave some indication of what was valued, what more was wanted, and what changes were considered desirable. The responses are summarized in tables 14b, c, d and e under the four headings useful, new ideas, need more details, and consequential changes.

The responses to the question about usefulness (table 14b) suggested that while many of the ideas were familiar, some of the teachers had not previously looked at them systematically. The usefulness of a range of development models, the overview, effectiveness and influences on development suggest that some teachers are thinking more about the professional development process and accepting responsibility for it.

Table 14b Aspects of the guide seen as useful

useful aspects	number of comments
range of development models	8
overview, rationale and aims	6
effectiveness	5
influences on development	5
needs appraisal schemes	4
planning	3
responsibility for development	2

From the summary of new ideas from the guide (table 14c) the main aspect considered new by the readers was Bolam's matrix (table 5a, p.46). This was used to bring the various components of development together and to emphasize the need for all of them in concert if professional development is to be effective. Bolam's matrix represents a critical idea in the planning process so the positive response to it wa pleasing.

Table 14c Aspects of the guide that were new

new ideas	number of comments
importance of planning	3
change mechanisms	2
components in matrix (trying out, reflection, implementation and application)	4
focus on issues	1
costs	1
resources (excuse not reason)	1
time needed for change	1
variety of possibilities	1

Needs appraisal was identified as being a useful idea, in table 14b, but more detail was perceived as needed about appraisal (see table 14d) than any other aspect. From the interviews it appeared that needs appraisal had been a major issue at a Principal's conference and many of the schools were currently debating this topic. The need for more detail about both needs appraisal and the models for development suggests that some of the readers are involved in planning for development.

Table 14d Aspects of the guide seen as needing more detail

more detail needed	number of comments
needs appraisal (& self assessment)	8
models (including action research and project-based models)	5
costs	2
guidance	1
change process	1
case studies	1

A number of responses suggested that changes were being considered because of the guide (see table 14e). This fits with the aims of the guide and in this respect the guide would be seen as successful. However a follow-up study would be needed to see if the changes were in the direction that the guide was suggesting.

Table 14e Consequential changes being considered because of the guide

consequential changes	number of comments
planning and organization	4
needs appraisal (& self assessment)	3
more leadership from HOD	2
ownership	1
assessment of development activities	1
(various specific projects	5)

The virtual absence of second responses meant that it was not possible to find if the changes proposed were being planned and implemented. Further responses would have been unlikely to show this as the timing for the development of in-school programmes was quite inopportune. The schools had received the new mathematics curriculum and had been invited to be involved in development activities partially funded by the Ministry. This meant cheaper professional development, the school could claim to have given many of the teachers development, and the heads of department would not need to take initiatives.

The suggestions from the heads of department on their response sheets included longer-term planning, needs appraisal, developing ownership, assessment of development activities, and more hands-on guidance. Only one head of department mentioned the same things in his final interview which suggests that the focus for development had moved to Ministry-provided development.

Other comments Most other comments were general. Six suggested small changes for a new edition, two stressed the importance of ownership of professional development, one suggested that the guide was good for reflection but not as immediately useful as the MCTP material (Owen et al, 1988—D.53) and two were the negative comments reported below.

Negative comments were received from two older (over 50) teachers about one paragraph. Both an older HOD in an interview, and an older teacher on a response sheet strongly objected to the section on ages and stages (Appendix E, p.238). This was intended to suggest the possibility that some older teachers go into a 'declining competence' stage but had been read as implying that all teachers go through this stage. The HOD also pointed out a number of grammatical and typographical errors in the draft.

The comments highlighted the need to have guides sensitively edited, they indicated a number of editorial changes that would need to be made if the guide was to be used in the future, and they showed that at least some of the respondents had read the guide in a very detailed way.

14.6 Conclusions

The guide was generally perceived as having some useful and relevant information in it. This information relates to the underlying themes on which it was based—an in-school focus is desirable, planning and leadership is necessary, an ethos of ongoing growth is preferable to imposed change and remediation of deficits, and an understanding of how the process of development contributes to its success. The acceptance of some of these ideas is one measure of success for the guide.

Having analysed the comments on teachers guides from the interviews and the response sheets, and considered how teachers guides in general contribute to development activities, it appears that teachers guides asking for change in teacher behaviour would contribute more to development if they are used as components within a bigger process and not seen as ends in themselves. This confirmed the researcher's view about teachers guides and about the need to have ongoing in-school development programmes in which such components can be incorporated. The findings also fit with the ideas expressed in the literature review (5.2, p.45) where new ideas are seen as only one component in a professional development programme.

While no significant changes in professional development were reported by the fourteen heads of department that might be directly attributable to

the guide, there were many reasons for this. Firstly, as mentioned previously, the implementation of Ministry development contracts overtook this project; secondly, the length of time of four school months would hardly be enough to establish new planning procedures and initiate new activities; and thirdly, as indicated in 13.2 (p.180), many of the heads of department felt in need of development themselves to upgrade their skills to enable them to organize a professional development programme successfully. For long-term success the guide requires time to be assimilated, and then time and support for the head of department to trial some of the suggestions. In the short-term the guide appeared to raise some issues and help inform the discretion of some teachers and heads of department.

The guide included ideas related to all its aims outlined in 14.2 (p.188). The responses to it suggest that some aspects of professional development were being regarded as more problematic and the readers were considering development from a broader perspective. Within the framework of this thesis where teacher growth rather than imposed change is being supported, this broader perspective is all that could be hoped for and the guide could therefore be regarded as successful.

PART E CONCLUSIONS

Chapter 15	Reflecting on the research and the literature	197
Chapter 16	Recommendations and further research	214

This project has had three main parts—the literature review, some research that looked at the professional development needs of mathematics teachers and how they might be provided, and then a more intensive look at school-based development. This concluding section brings together the findings from these three parts in chapter 15 . This is brief summary because many issues have already emerged from the data and the literature been incorporated into the study.

The final chapter presents a number of recommendations that emerge from the study. These have been grouped according to the various issues addressed.

Chapter 15 REFLECTING ON THE RESEARCH AND THE LITERATURE

15.0 Contents

15.1 Research questions 197
15.2 Overview of professional development 197
15.3 Organization of professional development 199
15.4 Leadership for professional development 207
15.5 Related administrative decisions 210
15.6 Summary 212

15.1 Research questions

The two initial questions which this study sought to address were:

1 What are the professional development needs of high school mathematics teachers?

2 How might these needs best be met?

These questions led to three further questions:

3 What model(s) for development would be appropriate?

4 What influences affect school-based professional development?

5 Can a teachers guide, incorporating the findings from question 2, help schools with the professional development of mathematics teachers?

This chapter brings together the findings from the literature (part B, chapters 4–7) and the research (parts C and D, chapters 8–11 and 12–14) and provides responses to the research questions.

The data can be summarized in terms of three themes:

i overview of professional development,

ii organization of professional development, and

iii leadership for professional development.

These are used to categorize the main ideas from the research data and relate them to the findings from the literature

15.2 Overview of professional development

Teachers and heads of department tend to have a pragmatic approach to professional development based on experience but lack a theoretical overview. Their view is usually that the purpose of professional development is to overcome deficiencies and to implement policy. The literature, on the other hand, has shifted the focus towards the notion of

lifelong learning for teachers as the purpose for development. Both views are compatible with the goal of achieving high quality teaching in order to improve learning, a goal with which all seem to agree.

The view of development as an ongoing process of teachers learning implies:

i a growth model for development rather than imposed change;
ii building on strengths rather than focusing on deficits; and
iii the establishment of a climate and structure for continual growth, rather than a stop-start programme largely based on matching individuals with development opportunities offered by others.

Teachers know about development, have been involved in it to varying degrees since they started teaching, but most have not reflected on the process. Building an understanding of the process of professional development was identified in the literature as an important metacognitive aspect of the development process. Linked to this was the need to have an understanding of the different ideas about how people learn (students and teachers). The literature emphasized a shift from behaviouristic (or transmission) to constructivist views as important for children's learning and in the design of adult learning—in this case, professional development. Constructivist views are increasingly underpinning mathematics curricula around the world.

The literature also suggested that teachers need to understand how the nature of mathematics is changing. The two main changes impacting on school mathematics are the increasing emphasis on mathematical process (what mathematicians do), and the influence of calculators and computers.

Many teachers viewed professional development as restricted to learning in the professional domain. The literature suggests that development has social and personal dimensions as well as the professional one and that these need to be taken into account. These dimensions include dealing with feelings and developing collaborative ways of working and relating with others.

The initial two research questions (what are the professional development needs of high school mathematics teachers? and how might these needs best be met?) are partly answered within this overview. While the researcher had expected to find specific topics for development and specific methods of delivery, this study points to the need for a shift from specifics to a more general approach which will facilitate the ongoing growth of teachers.

15.3 Organization of professional development

If professional development is to facilitate the ongoing growth of teachers, then an ethos for ongoing growth will need to be established within each school. Ideally this will be at least department-wide, if not school-wide, and have designated people, probably heads of department, taking leadership roles.

Such an ethos, centred on in-school development, is both a pragmatic way of organizing development in terms of the costs of development and the ability to include the necessary development components, and is professional in terms of the long-term professionalization of teaching.

Current professional development activities reflect what was available in the past. Little consideration has been given to alternative approaches or to ensure that the current methods are modified to become effective. A minority of schools are using in-school development and when this is well designed and ongoing, it reflects the approach that this study finds likely to be the most satisfactory. With New Zealand schools experiencing an upheaval as responsibilities are restructured, and more of the resources and control of professional development is being devolved to schools, the time is opportune for a change. However, very little experience has yet been built up with respect to the organization of development, particularly ongoing and in-school development.

From the literature and the research four organizational aspects of professional development emerge as needing consideration:

i the possible foci,
ii components in programmes,
iii influencing factors, and
iv development models.

Foci for development

The research data and the literature review in this study identified three main foci for professional development—the teacher, the school, and the subject mathematics. These represent a broad range of interests and needs that reflect the various stages of teaching careers within a typical staff—teachers who are beginning, new (from other schools), developing, experienced, considering promotion, and so on. It is unlikely that a single focus for development will be suitable for them all. Indeed, it does not seem possible to list specific needs: the question of needs appears quite complex.

Three other points also emerged. The first is to do with possible roles of the teacher. From the literature, phrases such as 'teacher as researcher' emerged but the teachers and heads of departments had a narrower focus, their concern being with teaching. For instance, with respect to development activities, they asked 'what do I do as a teacher?' This seems to reflect the view of changing first what they have most control of in their lives in the classroom, which is, themselves and what they do. If they focus on constructivist ideas about learning and its implications then they may raise questions such as 'how might children interpret these ideas'. Asking such questions could help them develop a role as researchers. This leads into the second point which is to do with learning theory.

An important change in mathematics education has been new ideas about learning. The emergence of constructivism as a result of research on cognitive development has helped some people in education change their views of learning. They now believe that coming to know is an active process, that learning is influenced by prior experience and by interest, and that learning means interpreting ideas and building up frameworks of ideas to make sense of one's world. This conflicts with the earlier idea of learning being the reception of objective knowledge. The literature is ahead of teachers in this respect and many teachers who have neither opportunities to study learning theory nor an interest in it seem to ignore it. Constructivism impinges on curriculum, classroom learning and adult learning (including professional development). Therefore any understanding about these three areas requires at least an understanding of what constructivists believe.

In terms of professional development, the differences between adult learning and child learning are related mainly to two things, the increased motivation and the richer and more robust set of prior experiences that adults bring to the learning. The common ground is that one makes sense of both children's and adult's learning through the ideas of constructivism. Unfortunately this perspective has had little impact on teachers because professional development has not focused on learning theory and generally teachers have not reflected on it.

A final point is that curriculum and school scheme development provide a context for school-based professional development. The present curriculum has been identified by schools as being broadly concerned with processes, teaching approaches, assessment, and context as well as content; and each of these topics would be areas for development for some teachers. Such opportunities arise with the introduction of any new curriculum and with regular revisions of school schemes, but, with the present curriculum initiative, the provision of Ministry teacher development contracts has temporarily shifted the leadership role from the heads of department to the external providers. This is not to say that contracts should not occur but, like teacher guides and other resources, they need to be viewed as starting points for in-school work. Perhaps an obligation for this ongoing aspect needs to be negotiated.

Components

As well as considering the focus for development, organizers of professional development should consider the components that need to be included in programmes to make them successful. Bolam's matrix (p.46) emphasized the need to include:

i a presentation or description of new skills,
ii opportunities to model these skills,
iii opportunities for practice of them,
iv feedback on performance, and
v assistance on the job.

From the literature this list of components can be expanded (see p.47). The other components are an initial preparation and planning one; and a final stage where new skills and ideas are built into the teachers' theoretical frameworks and their practice. When possible, the teachers should be empowered to take an increased role as initiators of development activities.

New ideas and new skills are often looked for outside the school but the research data indicated that considerable expertise exists within schools staff, and that sharing of experiences, new resources, teachers guides and professional reading are low-cost sources of ideas. These alternative sources could well become the starting point for ongoing and in-school development rather than visits from advisers or consultants.

Opportunities for the modelling of new strategies and for practice sessions in real or simulated situations need to be built into professional development programmes. This is being done to a greater extent when workshops rather than lectures are the format for activities at teacher refresher courses and other conferences. Such session are very acceptable to teachers but they need to be followed with an ongoing programme if they are to have a long-term effect.

Feedback on trials through sharing or anecdoting sessions, and assistance and support (professional, personal, social, and practical) are the final two stages identified by Bolam's matrix. They are the two components that have not generally been part of development yet his idea that they are essential if the new skills are to be applied on-the-job is reinforced by others in the literature.

The additional components of preparing and planning involve, getting teachers to see their work and isolation as problematic, helping them become convinced that they want to be involved in development and, planning and organizing the professional development programme.

The final stage of changing one's theoretical framework requires the ideas to be reflected on further. The empowering stage is one that a facilitator can encourage by providing opportunities and support for the participants in programmes to move forward.

No development activities that impinged on the schools in this research showed evidence of this range of stages. If future activities are to be effective then cognizance needs to be given to these. Because of the complexity of these steps and the need for continual professional interaction, the choice of a mainly in-school format seems appropriate. This is supported by the research and by a concern about cost.

The role of the Ministry in such a complex process is problematic. At most it can provide some new ideas either through advisers or resources—videos, teachers guides and other forms of professional reading. Regardless of how desirable is the stimulus provided in this way for departments and individual teachers, it needs to be viewed as just one component of the professional development process.

This argument that new ideas are one of five main components for successful professional development puts into perspective the development and trialling of the teachers guide in an attempt to find an answer to the fifth research question. In hindsight it might have been better to organize case studies with two or three schools that made a commitment to trial the guide by working through all the components . In reality such a trial would have been difficult to arrange because of the external pressures on mathematics departments to implement the new curriculum.

Influencing factors

Many factors affect school-based professional development. These include the existence (or otherwise) of an ethos for ongoing change, the qualities of leadership, the acceptance of the personal and social dimensions as well as the professional aspects to change, the acceptance of varied needs, and an understanding about the components of development (ideas, modelling, practice, feedback, and support). These all need to be considered in planning professional development programmes.

The other important influencing factors that were pointed out by both the research and literature were related to location, time, feelings, cost and effectiveness. A number of minor influences also emerged. Another group related to leadership and responsibility are dealt with in section 15.4 (p.207).

One clear message from the literature was that development activities undertaken in isolation from teachers' ongoing classroom responsibilities seldom have much impact on teaching practices or student learning. This suggests that more focus on in-school activities is desirable. In the research in-school activity was occurring where consultants and advisers were working in schools, but generally

courses and conferences were remote from schools. Only six of the fourteen schools organized department meetings that focused on professional development and in only two schools were these meetings regular and frequent (weekly).

The second major influencing factor is time, and concern about it came from both the research and the literature. It was clear that development activities should be spread over a period so that participants could trial ideas and share experiences with colleagues. This was not a major component in the professional development activities that schools were involved in during the research, the exception being tertiary study. But study, while it is both spread over time and ongoing, is not usually built on the expertise of the participants. It is usually remote from the classroom, and it does not always relate to the needs of participants in terms of classroom practice. It would not be difficult to modify the various forms of development to build in this time component if most of the components occur in the school.

Another aspect of time was whether professional development should occur in school time or in teachers' time. The research suggests that some school time should be allocated but as teachers see the value of being involved in change, they will also contribute some of their time.

A concern about time for change was seen in the design of some development activities which might be called 'quick-fix' solutions. In these, external agents had decided on the focus for development but inadequate time was provided. This criticism needs to be tempered by the realization that they were trying with minimal resources to have some impact with a large number of people. The 'quick-fix' difficulty is also related to whether one sees development as a process or an event. The literature was clear—the emphasis should be on a process (which is accomplished by individuals, is highly personalized, and involves growth). The traditional view focused on development as an event and is perhaps reinforced by a political system that seems to focus on outcomes with the achievement of an outcome being thought of as the completion of an event. Most of the teachers had not experienced development activities that were other than event focused, and their views consequently lagged behind the literature.

The third group of factors was to do with the feelings of people involved in professional development. A number of these important affective influences emerged from the literature—in particular predispositions to change; feelings about risk taking; personal insecurity, lack of confidence, and fear of failure; fear of loss of control; cultural beliefs and behavioural norms that conflict with change; trust (or lack of trust) in management, unions, and/or colleagues. There was no evidence of these anxieties being discussed in schools nor strategies being in place to help participants come to terms with them or to see them as part of the change process.

The fourth major influence was to do with finance although the cost of professional development needs to be considered alongside its effectiveness. Both the direct costs of development borne by the schools (or the education system) and the indirect costs borne by the teachers are significant. Only four heads of department were concerned that their development budget for the payment of direct costs was limited (although, from later informal comments from some of the heads of department, this seems to be changing as pressures on school expenditure increases). The indirect costs were seen as significant by some teachers and may be a reason for lack of participation.

If development activities were extended over time this would increase either the direct cost for teacher relief (during school time) or the indirect cost to teachers (for their own time). If development occurred mainly in the school then travel budgets would be reduced significantly. While the problems of costs remain it seems worthwhile to consider costs alongside effectiveness. Unfortunately, while the literature talks of accountability, there is little to help managers of professional development in terms of effectiveness.

Some minor influences arose, amongst which were needs appraisal and motivation. Needs appraisal seems linked to the deficit view of professional development rather than the teacher growth view and the pros and cons of needs appraisal schemes were discussed in the literature. At the same time, while a number of schemes were being introduced into schools; the research revealed a fear among teachers that information gained might also be used for performance reviews or other

purposes. While individual needs may be identified through appraisal schemes, the literature suggests that institutional needs might be better identified with a development plan. No departments had a development plan although five contributed to a school plan. If this plan is compiled cooperatively with an input from all the mathematics teachers then it could be useful in ascertaining some foci for development.

The other minor influence was the question of motivation. Some writers claimed that positive incentives need to be paid to teachers to participate but others suggested that the satisfaction achieved from participation will be sufficient pay-off once teachers get involved in a growth model of development. With most development activities some teachers seem to want to be involved but, when an imposed change is perceived as a waste of time, they either resist or adapt the change. If the control of development rests with the teachers then they are unlikely to pursue changes in which they see little value. With teacher control more satisfaction is likely to be experienced.

Models for development

A number of models for development and methods of delivery have been discussed in the literature. These included the research-development-diffusion, problem-solving, social-interaction, linkage, and evolutionary planning models (see 5.4, p.55). The possible modes of delivery for professional development are varied and were listed in table 5c (p.53). Change in the past has mostly been based on the research-development-dissemination model, usually with a focus on imposed curriculum changes. Presently the focus is on content standards in the United States and new curriculum documents in England and New Zealand. School organization has sometimes been changed by an action research programme, and sometimes by legislation. The industrial approach to change through total quality management is being tried in some schools in the United States. Articulation of goals and working towards achieving these is another approach which is gaining popularity, and when it is done on a very wide front it is now referred to as systemic change.

It is likely that all of these approaches have had some success with some people and all of them have had their share of failure. What we tried to do in the past was develop a theory that would work for all

schools in all situations and would somehow enable the educational community to implement all the desirable changes regardless of where they originated. Now an acknowledgment is emerging that the process is more complex, and the needs and the possible foci are more varied.

With this in mind the third research question about appropriate models for development does not have a simple answer. The best we can do is encourage schools and mathematics departments to consider their situation and to come up with or adapt a model that suits them. Such a model will need to consider the three aspects to development (personal, social and professional), the possible foci, the essential components in programmes, and the influencing factors. If this is done cooperatively it will help develop the collaborative leadership and responsibility which is the focus of the next section.

15.4 Leadership for professional development

Control and empowerment

Numerous leadership aspects arose in both the research and the literature. The first was to do with who controls development. The differences between the imposed-change and the growth perspectives on professional development are linked with whether teachers should lead curriculum change or follow policy decisions made about curriculum and assessment. In the present restructured environment the matter of control is causing confusion. The philosophy of devolution suggests an empowerment model where schools take more control of staff and curriculum development and through these activities, become more professional. However, the control imposed by the Ministry through the imposition of curriculum initiatives and new assessment requirements emphasizes a political preference for a dependency model which aims at satisfying short term goals of politicians rather than encouraging professionalism.

The literature supports an empowerment model with the development of ownership and control by participants but many heads of department seemed to favour the dependency model. This may be because they are familiar with it or they are unaware of the alternatives. Important questions to emerge were, who will gain from the development activities, who has to change, who decides that they have to change, and who is directing the change? Again the literature generally favoured

self direction which fits with the emerging preference in this study for collaborative projects where decisions arise from the grassroots, rather than being imposed.

Responsibility

In practice a number of groups assume they have responsibility for development. These included the ministry, local in-service committees, principals, professional development coordinators, heads of department and individual teachers. The heads of department who were interviewed seemed to favour a range of groups being involved. This may have been based on a pragmatic viewpoint or reflected what had occurred in the past. Unfortunately in the past, and possibly because many groups were involved, the result was that a number of heads of department did minimal planning and relied on outsiders.

When the head of department does take a leadership role it can be either imposed or collaborative leadership. The literature supports the latter and sees the responsibility of each individual teacher as being important. One school had made an attempt to make individual teachers personally responsible and in two others the departments seemed to take a more active role facilitated by the head of department. This initiative fits with the views presented in some of the literature. Within such a collaborative framework it is easy to see the duties of a head of department as including both professional and curriculum development. This view was supported in both the research and literature. However, while the heads of department who were interviewed accepted some responsibility for development a number of them only reacted to professional development opportunities rather than taking a proactive leadership role.

The acceptance of a reactive rather than a proactive leadership role by some heads of department may suggest that some external pressure is needed and that the provision of specific stimulus material to inform the discretion of heads of department (and staff) is desirable. This is a tension that is likely to continue as the responsibility for development shifts and the school (or department) builds up a culture for change. From the experiences of the schools that were becoming more change oriented, it seems that as confidence builds, teachers do look outside for stimulus, they do accept ideas from new curriculum, and they do this

because they want to, not because of pressure. The old adage, "you can lead a horse to water but you can't make it drink" seems to sum up the uselessness of exerting pressure on departments. This research suggests that what is needed more than ideas is modelling of the preferred ways of working, and support and encouragement to change.

While the head of the department seems the obvious person to take a leadership role within the department, there may be exceptions to this in small schools and in larger schools where there is more than one position of responsibility within the department. In these cases the leadership role may be delegated. In fact there was no evidence of this in the schools visited although two smaller ones did say that sharing was desirable.

Ownership of development

Another aspect of collaborative leadership relates to the ownership of change. Ownership was recognized in the literature but was not being developed by the mathematics staff in the schools since the main activities were run by external groups away from the school. If such activities were viewed as starters and were followed up in schools, or if the development was school-based, then a sense of ownership would be more likely to develop.

The need to identify a sense of vision or direction, perhaps in the form of a mission statement, and to develop some aims for the department from such a statement has been mentioned in the literature. Achieving this is also very dependent on the style of leadership. The process should involve all the staff and they should be encouraged to see its advantages in ensuring that resources are channelled appropriately. No schools showed evidence of such a process and in the five schools that did have school management plans, the task seemed to involve only heads of department.

Professional development for heads of department

A proactive style of leadership was identified in the research as being linked with successful development. The research data indicated that the development of such a style of management is one area in which most heads of department may need assistance. To move the focus from externally-organized development to an ongoing in-school programme may require assistance. Some training of heads of department in these

matters appears necessary. Such training could be held within a school and involve heads of all subject departments. While responsibility rests with the senior professional leaders of schools, encouragement from the national level would help stimulate such activity.

Providers

The literature on change indicates that other teachers are often the preferred source of new ideas and indeed, can be very effective sources. If this relates to all aspects of mathematics education (content, processes, context, learning theory, and teaching issues), then it implies visits to colleagues classrooms, time for sharing ideas, meetings and courses run by colleagues rather than lectures by experts, teacher-initiated meetings with advisers, and externally-produced resources and teachers guides from which the teachers can extract suggestions for their own consideration. In practice, because of time constraints, the externally-run activities are often used even though not preferred. While some of the larger schools in this study felt confident about having the necessary expertise for in-school teacher development, only one based most of their efforts on in-school activity. Again this probably reflects past experiences rather than a considered decision about planning development.

According to the literature other sources of ideas such as teacher guides, texts, videos, and journals are an acceptable form of non-threatening outside influence. However, the research suggests that not only are they non-threatening, but in many instances they have little effect on teachers' ideas and practice. Perhaps this is not surprising as constructivist ideas suggest that without special challenge, such material is likely to be interpreted within teachers' existing cognitive frameworks. In terms of the components of a successful development activity such resources need to be seen as just one component, a component that needs to be supplemented by the support of in-school change agents. Unfortunately little evidence of such support and challenge was reported.

The present main providers of in-service activity identified were the:

- Ministry through contracts and advisers,
- local in-service committees,
- national teacher refresher course committee,

- mathematics teacher associations and special interest networks,
- tertiary institutions with study opportunities, and
- schools.

Of these, the schools do the least but ironically are best able to provide many of the requirements for effective development—practising, receiving feedback, supporting, and assisting. Tertiary institutions provided ongoing development opportunities but study for qualifications does not usually satisfy the specific needs of all participants. Ministry contracts allow for negotiation of focus but are usually limited to about six sessions, and other groups tend to run one-off meetings which are not effective ways to implement change. In time, as Ministry contracts move to other subjects, other providers will need to modify their approaches to make them more appropriate. To do so they will need to understand the professional development process more fully. How they can gain such understanding is an open question but may involve tertiary study, professional reading, or sharing and reflecting with colleagues.

15.5 Related administrative decisions

Money and time

Money and time have been identified both by the research and in the literature as being important administrative inputs into development activities. They have already been mentioned as influencing factors in development programmes but it is important to look at them in terms of administration and effectiveness. To some extent they are interchangeable as money can buy time for relief and both can be regarded as costs.

Needs appraisal

There seems to be little evidence from heads of department or from the literature to support formal needs appraisal schemes if the development environment that is wanted is a teacher-learning one. If the school is dominated by management by objectives then a formal appraisal is likely to be imposed. When such a scheme is imposed in a teacher learning environment the best that a department can do is ensure that such an appraisal is used after the development programme has been in place for some time as then the needs that will emerge are likely to be those that the teachers have already decided upon.

A possible positive aspect of an appraisal scheme is that people have a chance to reflect on where they are going and would like to be going, but this can be achieved in other less threatening ways such as being involved in planning for development that focuses on improving the system rather than the individual.

Costs and effectiveness

Costs for development activities are significant, vary between schools and depend on how development is organized. In this research there was little evidence of consideration being given to costs. The philosophy seemed to be to do what you can until the money runs out. This is probably a temporary phenomenon while schools slowly adjust to taking responsibility for development.

For reasons reported already, the most effective development will be in-school, ongoing and based mainly on the expertise of the school staff. Because it is virtually impossible to have regular teach-relief provided, and none of the 14 schools have yet timetabled all departments into meeting times, such development is most likely to be in the teachers' own time. This shifts the burden of costs from the school so that they become indirect costs borne by the teachers. This may become inequitable if only some departments or some teachers are involved in this form of development.

Evaluation and effectiveness

It is very difficult to evaluate specific development activities in terms of the long term improvements in learning which are the ultimate aim of most development activities. At the same time administrative decisions need to be based on costs and effectiveness. In 6.8 (p.80) some suggestions were made to help in this process.

None of the heads of department interviewed mentioned more than simple monitoring of activities and none mentioned planning in which effectiveness, apart from an intuitive measure, was used as a criterion.

15.6 Summary

In summary the general aim of this study, to explore professional development as it relates to high school mathematics teachers, has been achieved, but the research questions have far more complex answers than was originally anticipated.

A consideration of the components for development and the need for leadership contributed to the fourth question about, what influences affect school-based professional development? For the rest, acceptance of professional development as a multidimensional and complex process and acceptance of schools, mathematics departments, and individual teachers as all being unique, means that the needs, how they might be met and the model for development must vary from setting to setting. A teachers guide is unlikely to be of benefit in isolation but it could well be useful as a component of this complex development process.

From this exploration a number of recommendations can be made about professional development. These are the subject of the final chapter.

Chapter 16 RECOMMENDATIONS AND FURTHER RESEARCH

16.0 Contents

16.1 Introduction 214
16.2 General recommendations 214
16.3 National policy 215
16.4 National, regional and local networks 216
16.5 Pre-service education 216
16.6 Schools 216
16.7 Individual teachers 218
16.8 Further research 218

16.1 Introduction

From the conclusions in chapter 15, the ideas expressed by the participants in the research, and the overall impressions gained by the researcher, a number of recommendations can be made. These relate to—general matters, national policy, teacher networks, pre-service education, schools, individual teachers, and future research. The recommendations in this chapter are grouped in these categories.

From a post-positivist perspective knowledge is constructed. This implies that it is based on the history and the values of those who construct it. In this research, professional development is based on humanistic values for a society where the main risk in taking action is that of personal failure. In different societies the risk of non-conformity or the risk of loss of face may be enough to stop people trying new initiatives. Thus the model suggested and the recommendations listed are made from a New Zealand perspective and may need to be reconsidered and modified for other settings.

16.2 General recommendations

The *quick-fix* solution to implementation and to development problems is not educationally effective. This needs to be acknowledged and resources channelled into activities that are likely to be effective.

Ideally professional development is a continuous process of learning for all teachers and not one that merely focuses on new initiatives, although it will focus on these when they arise.

Professional development is more likely to be effective if it is mainly school-based. Where this is not practical because of very small departments, then either departments with common interests within schools, or groups of schools might form clusters for development.

The control of professional development of mathematics teachers should be with the teachers of the mathematics department and they should be allowed and encouraged to develop ownership of both the process and products.

16.3 National Policy

Virtually all resources for professional development need to be devolved to schools. A small budget could be retained by the Ministry for activities such as seeding initiatives (such as head of department training), stimulating networks, and providing professional reading (teacher guides).

Ideally such devolution would be based on an equity formula that takes into account the needs of

i smaller schools in remote areas to form cluster groups (and the greater travel involved), and

ii schools developing bilingual units (with their burden of language and other resources).

To assist schools in their planning it would be beneficial if a long-term (five to ten year) rolling development plan indicating the timing and nature of proposed central initiatives (curriculum, resource and assessment developments) was made available to schools each year. (Accepting the political realities, such a plan might signal what will definitely occur in the next two years and what is planned to occur in the years after that.)

Curriculum and teacher development are intertwined but the Ministry is giving mixed messages by retaining considerable central control of curriculum and assessment while using a rhetoric of devolution with respect to other aspects of education. There is a need to ensure that schools have considerable opportunities to make curriculum decisions even if the Ministry is responsible for overall frameworks. To assist in

this, Ministry documents other than framework documents could remain as guide material.

16.4 National, regional and local networks

There is a need to encourage the growth of national, regional and local networks that empower teachers. These could be nurtured by the provision of seeding funding for exploratory studies and the production of guide material.

A small number of mathematics teachers find themselves unable to interact frequently with others. These include teachers in small schools, remote schools, hostile staffs, sexist environments, and with pressing out-of-school commitments such as childcare. Alternative ways of facilitating interaction between these teachers, including the use of E-mail, electronic bulletin boards and teleconferencing, could be investigated to see whether they achieve significant change.

16.5 Pre-service education

Pre-service education as well as in-service development is a long-term change process. With respect to in-service it would be advantageous if, during the pre-service stage, prospective teachers were encouraged to plan for their development during the induction period and to be aware of the range of in-service opportunities that they can use throughout their careers. This would help build a professional development ethos in the schools they work in.

16.6 Schools

Schools need to establish and maintain a culture of teacher-learning, that is, a professional development ethos. Frequent and regular department meetings that focus on professional matters are a part of this. Departmental activities should also be seen in the wider context of in-school development as many mathematics teachers will also want to be involved with these broader initiatives.

As part of the planning process each mathematics department needs to be encouraged to develop (and review) a mission statement with general goals within the philosophy of their school. Such a statement would provide criteria to focus the development activities.

Another point needing consideration is teachers' job descriptions. These need to emphasize the shared responsibility that each teacher has with the school that employs them for both their own and their colleagues' professional development.

Heads of mathematics departments have the responsibility to organize the ongoing professional development for their staff. For the heads of department who are uncomfortable with this responsibility, schools might provide development activities in leadership.

Where possible, professional development activities should be timetabled during the school day in non-contact time. This would help ensure that all teachers can attend and it would emphasize the importance that the school places on such activities.

Regional and national courses and conferences, teachers guides and other new resources, together with advisers and contract involvement, need to be seen as one component within professional development. These are useful if they are used as a starting point for sharing, trialling, feedback and support within the school.

Many professional development needs of high school mathematics teachers are similar to the needs of teachers of other subjects and the traditional subject/department division within schools may sometimes hinder more general development activities. Collaboration in many activities should move beyond the school and may include board, parents, the community and students.

Formal needs appraisal could be replaced with open and honest staff deliberation on the needs of the school and their department. This would give the staff the greater feeling of ownership and control which is desirable.

Professional development activities will be more effective if teachers understand the process of change, their learning process in professional development, and how students learn. Ideally this metacognitive aspect will be incorporated into development activities.

Planned development activities need to include all the necessary components to ensure that the changes are integrated into school programmes, are implemented in a cost effective way, and that participants feel totally involved in the development process.

Professional reading needs to be encouraged in schools as part of the development programme as it represents a cost effective way of gaining new ideas which are an important component of development.

Schools need to support and affirm individual teachers and groups of teachers who take development initiatives. In particular young teachers and those who are willing to take 'risky' initiatives should be encouraged.

16.7 Individual teachers

Each teacher needs to be encouraged to view professional development as an ongoing right and a personal responsibility. Teachers need to plan for it personally as well as with colleagues, and ensure that personal and social as well as professional needs are met .

Teachers need to consider legislated initiatives alongside their personal and other school needs, accept that all can not be done at once, and prioritize the activities they will be involved in.

16.8 Further research

This research has investigated the needs of mathematics teachers as seen by the high school mathematics teaching and mathematics education community and was limited to that group. The study needs to be extended by interviews and discussions with other teachers (part-time mathematics teachers, teachers of other subjects, and primary and tertiary teachers), with students (mathematics and non mathematics), and with others in the community (parents, board members, and employers).

The personal and social dimensions of development have been stressed as important. There is a need to investigate ways that these dimensions might be incorporated into school-based development.

In-school programmes to help heads of department become better facilitators of professional development need to be organized. Such programmes might be evaluated via a longitudinal study to provide feedback on their effectiveness.

Future teacher guides issued to schools need to be linked with in-school development activities. Such guides with linked activities could then be evaluated in a small number of case studies to see whether the guides were a useful stimulus.

Current professional development needs and wants identified by teachers, educators and policy documents could be summarized as a request for 'more of the same'. There is a need to broaden the base of activities beyond the New Zealand experience and to continually search for more effective professional development activities. This search needs to include consideration of approaches in non-English speaking places. If a small professional development group of creative thinkers was brought together to consider and generate new ideas, then these could be tried out over time and a systematic research study undertaken to determine their effects.

APPENDICES

Appendix A	Teacher interview schedules		221
	A.1	Introduction	221
	A.2	Principal	221
	A.3	Head of department	222
	A.4	Professional development coordinator	222
	A.5	Discussion sheet: professional development	222
	A.6	Mathematics teachers	224
	A.7	Possible follow-up topics	225
Appendix B	Questionnaire for mathematics educators		226
Appendix C	Policy documents		229
Appendix D	Head of department interview topics		234
	D.1	Pre-teachers guide interview	234
	D.2	Post-teachers guide interview	235
Appendix E	Draft teachers guide		237
	E.1	Introduction	238
	E.2	Aims	239
	E.3	Responsibility for professional development	240
	E.4	Rationale for development	241
	E.5	Planning for development	243
	E.6	Pre-planning stage	244
	E.7	What's available?	245
	E.8	Influences on development	246
	E.9	Models for development	249
	E.10	Costs of development	252
	E.11	Effective models	253
	E.12	Needs appraisal	254
	E.13	Planning stage	256
	E.14	Implementation and application	257
	E.15	Getting started	258
	E.16	Presentation and modelling	259
	E.17	Practice and trialing	259
	E.18	Feedback and reflection	260
	E.19	Support and assistance	262
	E.20	Evaluation stage	263
	E.21	Looking ahead	264
	E.22	Further reading	265
	E.23	Other references	265
	E.24	Response sheet 1	266
	E.25	Response sheet 2	267

Appendix A TEACHER INTERVIEW SCHEDULES

A.1 Introduction 221
A.2 Principal 221
A.3 Head of department 222
A.4 Professional development coordinator 222
A.5 Discussion sheet: professional development 222
A.6 Mathematics teachers 224
A.7 Possible follow-up topics 225

A.1 Introduction

The interview schedule was divided into questions for the principal only, questions for the head of department, a discussion sheet about professional development (not used after the first few interviews), questions for the professional development coordinator, and questions for all the mathematics teacher (including the head of department,).

A.2 Principal

Introduction — Names, purpose of research, taping, feedback, confidentiality.

Professional development — I will be talking to the HOD and the maths teachers later for their view on their professional development needs but I want to be able to see their comments within the schools overall functioning

- Could you please tell me about the school's policy on professional development?
  - Charter statement
  - Is this restricted further by budget difficulties?
  - Is there a per teacher budget item?
- What are the changes in professional development since the Picot restructuring?
- Who is responsible for professional development in the school?
  - Is there a preferred way of organizing professional development?
  - Are there any cross school or cross-curricular developments that need to take precedence over department needs?
- What opportunities does the school provide to enable teachers to reflect on teaching methods and update their curriculum content?
- What do you see as the main needs of the maths staff?
  - Is this different from the needs of other teachers?
- What constraints are there on professional development because of limited resources or for other reasons? (remoteness etc)
- Are there any other points about professional development in the school that you think would help my understanding?

A.3 Head of department

Introduction

Names, purpose of research, taping, feedback, confidentiality
I will later ask you the same questions as other teachers but I would like to know some school and mathematics administrative details.

School profile

- Roll (at each class level)
- Number doing mainstream maths, alternative maths, or an extra maths option (at each class level)
- No of full-time and part-time teachers teaching 100% maths, more than 50% maths, and less than 50% maths
- List names of teachers in the four categories:
  P/DP/SM HOD/PR List B Teachers List A Teachers
- Does the school have a professional-development coordinator? What is his/her name?
- Are there any other facts I should know about staffing in the mathematics department?

A4 Professional development coordinator

Introduction

- Names, purpose of research, taping, feedback, confidentiality

Questions

- Discussion of definition of professional development
- Please tell me about the school's policy on professional development?
- What practical difficulties arise in implementing the policy?
- Do you see as the maths staff as having any particular needs?
- Are there any other points about professional development in the school that you think would help my understanding.

A.5 Discussion sheet: professional development

My definition of professional development for a teacher is "learning that changes what the teacher does in the school." Such changes may be in a number of aspects of their work, and be caused (or impeded) by a number of opportunities and factors.

Table A5 Aspects of teachers work, opportunities and factors

Aspects of teachers work	Contributing (or Impeding) opportunities & factors
Curriculum Development Content Teaching Methods Assessment Classroom Management Personal / Social Dev. Attitudes Relationships Guidance Subject Form Dean Administration Other Other subjects Cross-curricular Extracurricular Special Needs	National Syllabus change Assessment change Teachers guides School Policy change or organizational change Scheme writing Resource change Position Promotion Change of school People Outside school (TC lecturer, adviser, inspector, community) Inside school (Principal, HOD, PR, List A coordinator, fellow teachers, students, parents) Print New resources Books or Periodicals Meetings In school (staff meetings, department meetings) Local (In-service, maths associations) National (TRC, Lopdell, conferences) International (visitors or conferences) Technological changes (calculators & computers) Further Study (night class, university)

Do you agree with this view?

Is their anything you think I should add (or you would prefer deleted)?

A.6 Mathematics teachers

These questions were used with the mathematics teachers including the head of department.

Introduction — Names, purpose of research, taping, feedback, confidentiality

Definitions — To get our discussion going look at this summary of professional development and decide whether you are happy with my definition.

Questions

• In your teaching careers what do you see as the aspects of your work that you have changed?

- Would you tell me about your teaching career and its ups and downs?
- University / T Col / first school / List A / other schools, any breaks?
- Which of these changes do you regard as 'critical'?

• Going through these one by one:

- what sort of encouragement did you get with these changes?
- what caused, helped, or impeded you in making these changes?

• What are your professional development needs in the next 5–10 years?

- Please elaborate? Are these the same as the mathematics department's professional development needs?
- How would you like these needs met?
- What support do you think is required for this to occur and what might impede it?

A.7 Possible follow-up topics

Head of department

- Regular meetings?
  - administration / professional matters?
  - attendance?
- Mathematics education publications (periodicals or books)?
- Job specification

Teacher

- Professional development
  - are you involved in planning your professional development?
  - what about in the past
    (what? which were valuable? who suggested you participate? what did you learn? how did this affect your teaching?)
- Communication
  - does someone in the school give you articles or direct your reading? do you get your ideas from courses or periodicals or other sources, do you have opportunities to share them?
- Performance review?
- Have you had much interaction with mathematics advisers?
- Does cross-curriculum professional development on topics such as assessment or classroom management occur in your school?
- Are you (or have you ever been) involved in any of:
  - school-based curriculum development (scheme writing)?
  - local or national curriculum initiatives?
  - local or national resource development activities?
  - local or national in-service initiatives?
- What professional development delivery system would best suit you?
  - why would this be more effective than other methods?
  - have you experienced this in the past?
  - do you prefer working by yourself, in small groups or in large groups? Why?
- What factors help you make changes?
  - what factors impede your making changes?
  - when is it easiest to make changes?
  - do you tell your students that you want to try something new?
  - is the senior management behind you when you try innovations

Appendix B QUESTIONNAIRE FOR MATHEMATICS EDUCATORS

Please return to: Andy Begg
Curriculum Development Division
Department of Education
P O Box 1379, Wellington

1 Name _____

2 Position _____

3 Time in Present Position _____

4 In your work with and observation of teachers in the forms 3-5 area, what are your concerns? (Please list them briefly, one line each)

_____

_____

_____

_____

_____

_____

_____

_____

_____

(Please continue on a separate sheet)

5 For teachers of forms 3-5, what are your priorities for teacher development? (One line each please)

_____

_____

_____

_____

_____

_____

_____

(Please continue on a separate sheet)

6 In forms 1 and 2, what different concerns do you have?
(one line each please)

(Please continue on a separate sheet)

7 In the senior secondary school (forms 5 to 7) what different concerns do you have?
(One line each please)

(Please continue on a separate sheet)

8 Are there any other teacher, curriculum, or resource development needs that you are aware of for the teaching of mathematics?

(Please continue on a separate sheet)

9 In identifying your concerns with teachers, do you use objective criteria, subjective judgements, or do you rely on the judgement of the teacher, the principal, or students? (Please give details)

(Please continue on a separate sheet)

10 In trying to ensure that some local initiatives occur in all districts after the new Ministry is set up, and that coordination occurs when more than one district have a similar concern, what local initiatives would you like your district involved in?

Forms 1 & 2

Forms 3 & 4

Forms 5 - 7

Appendix C LIST OF POLICY DOCUMENTS

New Zealand Mathematics Syllabuses

Department of Education (1989a).
Draft Syllabus Mathematics: Forms 5 to 7
Wellington: Department of Education D 1

Department of Education (1987a)
Mathematics: Forms 1 to 4, Syllabus for Schools
Wellington: Department of Education D 2

New Zealand Mathematics Teacher Guides

Department of Education (1988a)
Assessment Ideas in Mathematics
Wellington: Department of Education D 3

Department of Education (1988b)
Mathematics with Statistics: Supplement
Wellington: Department of Education D 4

Department of Education (1986a)
Introduction
Wellington: Department of Education D 5

Department of Education (1986b)
Ideas (Forms 3 & 4)
Wellington: Department of Education D 6

Department of Education (1986c)
Mathematics with Statistics (Form 7)
Wellington: Department of Education D 7

Department of Education (1986d)
Mathematics with Calculus, (Form 7)
Wellington: Department of Education D 8

Department of Education (1986e)
Mathematics Discussion Starters (Draft Edition)
Wellington: Department of Education D 9

Department of Education (1985b)
University Entrance Mathematics (Form 6)
Wellington: Department of Education D 10

Department of Education (1983a)
School Certificate Mathematics (Guide Notes for Teachers)
Wellington: Department of Education D 11

New Zealand Education Reports

Ministry of Education (1990a)
Guidelines for Success in Consultation
Wellington: Learning Media, Ministry of Education D 12

Ministry of Education (1990b)
Tomorrow's Standards
Wellington: Learning Media, Ministry of Education D 13

Ministry of Education (1990c) (Noel V Lough, Chairperson)
Today's Schools
Wellington: Ministry of Education D 14

Ministry of Education (1990d) (Jack Shallcrass, Chairperson)
School Development: Review of Advisory Services
Wellington: Ministry of Education D 15

Education Review Office (1990a)
National Special Review Teacher and ECE Personnel Development, Wellington: Education Review Office D 16

Department of Education (1989b)
Assessment for Better Learning (A Public Discussion Paper)
Wellington: Department of Education D 17

Department of Education (1989c)
Countering Sexism in Education
Wellington: Department of Education D 18

Department of Education (1989d)
Getting Started on Consultation
Wellington: Department of Education D 19

Department of Education (1989e)
Charter Framework
Wellington: Department of Education D 20

Department of Education (1988c)
Administering for Excellence
(Report of the Taskforce to Review Education Administration)
Wellington: Department of Education D 21

Department of Education (1988d)
Tomorrow's Schools
(The Reform of Education Administration in New Zealand)
Wellington: Department of Education D 22

Department of Education (1988e)
National Curriculum Statement (Draft)
Wellington: Department of Education D 23

Department of Education (1988f)
A Staff Development Kit to Support the Draft National Curriculum Statement
Wellington: Department of Education D 24
Incorporating drafts of
- Using Curriculum Principles In Staff Development
- Focusing On The Learner
- Promoting a Sense of Cultural Identity, Parts A & B
- Promoting Equity, Parts A& B
- Achieving Balance and Coherence
- Providing for Accountability

Department of Education (1987b)
The Curriculum Review (Report of the Committee to Review the Curriculum for Schools)
Wellington: Department of Education D 25

Department of Education (1987c)
Mathematics Achievement in New Zealand Secondary Schools (A Report on the Conduct in New Zealand of the Second International Mathematics Study within the International Association for the Evaluation of Educational Achievement)
Wellington: Department of Education D 26

Department of Education (1986f)
But will it get me a job? (A Leaver's Profile Resource Booklet) Wellington: Department of Education D 27

Department of Education (1986g).
Learning and Achieving
(Second Report of the Committee of Inquiry into Curriculum, Assessment, and Qualifications in Forms 5 - 7)
Wellington: Department of Education D 28

Education and Science Select Committee(1986)
Report on the Inquiry into the Quality of Teaching
Wellington: Government Printer D 29

Department of Education (1984a) Northern Regional Office
The HOD Manual (Draft Edition)
Auckland: Department of Education D 30

Department of Education (1984b)
A Review of the Core Curriculum for Schools
Wellington: Department of Education D 31

Department of Education (1984c)
Analysis of Submissions on the Report - A Review of the Core Curriculum for Schools
Wellington: Department of Education D 32

Department of Education (1983b).
Report of the Secondary School Staffing Working Party
Wellington: Department of Education D 33

Department of Education (1982)
Teacher Career and Promotion Study
Wellington: Department of Education D 34

Department of Education (1981)
State Secondary Schools in New Zealand: A Baseline Survey
Wellington: Department of Education D 35

Department of Education (1979)
Review of Teacher Training
Wellington: Department of Education D 36

Department of Education (1978)
Report of the Committee on the Registration and Discipline of Teachers Wellington: Department of Education D 37

Department of Education (1976)
Towards Partnership
(Report of the Committee on Secondary Education)
Wellington: Department of Education D 38

New Zealand Non-Government Reports and Guides

Gillespie, June & Spencer, Neil (1990)
The HOD Manual: A guide to middle management
(Revised edition) Dunedin: Dunedin College of Education Secondary Schools Advisory Services D 39

Gillespie, June (1990)
Starter Kit for the Induction of New Teachers (Updated edition) Dunedin: Dunedin College of Education Secondary Schools Advisory Services D 40

New Zealand Equals Network (1989)
Mathematics Teaching: Making Changes
Victoria Australia: Latitude Publications D 41

New Zealand Employers' Federation, (ed) Ross Pedder (1981)
Secondary Education and the Path to Work
Wellington: New Zealand Employers' Federation D 42

Werry, Bevan W (1980)
Mathematics in New Zealand Secondary School
Wellington: NZ Council for Educational Research D 43

Overseas Reports

DES/WO (1988) Department of Education and Science and the Welsh Office *Mathematics for ages 5 to 16* London: Her Majesty's Stationery Office D 44

Joffe, Lynn and Foxman, Derek (1989) for Assessment of Performance Unit *Communicating Mathematical Ideas: A practical interactive approach at ages 11 and 15* London: Her Majesty's Stationery Office D 45

DES (1987) Department of Education and Science Curriculum Matters 3, An HMI Series *Mathematics from 5 to 16* (Second edition, incorporating responses) London: Her Majesty's Stationery Office D 46

National Mathematics and Statistics CBL Review Panel (eds) (1986) *Will Mathematics Count* England: AUCBE D 47

DES/WO (1982) Department of Education and Science and the Welsh Office *Mathematics counts* Report of the Committee of Inquiry into the Teaching of Mathematics in Schools under the Chairmanship of Dr W H Cockcroft) London: Her Majesty's Stationery Office D 48

National Council of Teachers of Mathematics (1991) *Professional Standards for School Mathematics* Virginia, USA: NCTM D 49

National Council of Teachers of Mathematics (1989) *Curriculum and Evaluation Standards for School Mathematics* Virginia, USA: NCTM D 50

National Council of Teachers of Mathematics (1980) *An Agenda for Action* Virginia, USA: NCTM D 51

National Research Council (1989) *Everybody Counts* Washington, D.C.: National Academy Press D 52

Owen, John; Johnson, Neville; Clarke, Doug; Lovitt, Charles; Morony, Will (1988) *Guidelines for Consultants and Curriculum Leaders* The Mathematics Curriculum and Teaching Programme, Canberra: Curriculum Development Centre D 53

Appendix D HEAD OF DEPARTMENT INTERVIEW TOPICS

D.0 Contents

D.1 Pre-teachers guide interview 235
D.2 Post-teachers guide interview 236

D.1 Pre-teachers guide interview

Instructions: Questions to be asked of HOD before teachers guide is distributed

Background: Discussion on project, confidentiality, permission to tape

Discussion Focus:

- Defining Professional development
  - Focus - School improvement, subject focus, personal growth
  - Courses - In-service, day course, TRC, maths assn meetings
  - Projects - new curriculum, scheme, worksheets, assessments, etc
  - Study - tertiary, ASTU etc
  - (Have staff looked at the new curriculum draft?)
- Professional Development in the school
  - Budget (Mathematics department allocation)
  - Mathematics department plans
- Requests
  - Have any of your staff asked for anything in particular?
- Involvement
  - What have you and your staff been involved in this year?
- Needs
  - Does the school have a needs appraisal scheme?
  - Has the department met or done anything to plan for either professional development this year or for next year
- Organization
  - Have you as HOD organized any development activities this year?
  - Any department meetings that focussed on PD not administrivia?
- Assistance
  - What help do you think would be desirable for heads of department (like yourself) with respect to professional development
- Teachers Guides
  - What is your opinion about teachers guides in general? (this question was added for the last 6 of the 14 interviews)

D.2 Post-teachers guide interview

Instructions

Questions asked of heads of department 3–5 months (including summer vacation) after the teachers guide was distributed.

Discussion Focus

- Teachers guide on professional development
  - Have you had any reactions from your staff about the guide you distributed?
  - Any reactions from yourself?
- Teachers guides in general
  - Any reactions about teachers guides in general?
- 1993 Plans
  - Have any plans for teacher development come up at department meetings so far this year or are any others being planned (from last year)? If so, what focus? and what structure?
  - Has any one asked for anything in particular? If so, what focus?
  - Are you involved in the ministry teacher development contracts?
  - Are any of your staff hoping/planning to go to the NZAMT conference or to the teachers refresher course?
- Needs
  - Have any needs been identified by a school or department needs appraisal scheme?
- Assistance
  - What help do you want/need for professional development?
  - Would it help if professional development in maths was more closely allied with other subjects?
- Motivation
  - I'm trying to identify why some people are proactive while others are only reactive, Have you any idea what makes the difference?
- Control of development activities
  - Who do you think should be in control of curriculum activities (centre, region, schools)?
  - Should it be a curriculum document or just a framework?
  - Who do you think should be in control of teacher development activities (centre, region, schools)?

- What's different about you
  - How do you perceive yourself in terms of organizing professional development compared with other HODs? (Do more / do less / about the same)
  - An HOD has many duties, professional development is only one of these, which others are more important?
  - Do you think that you ought to put more / the same / or less effort into professional development?

- Your background (Ideally I might do a whole life history survey, but instead, can you tell me ...)
  - Is there any thing special in
    your own schooling
    or upbringing?
    or HODs you have worked under?
    or your mathematics qualifications?
    or your education qualifications?
    or your ambition within the profession
    or boredom with your career
    or any other personal factors?

- School climate
  - In terms of innovation and change, is this school more supportive / less / or the same as other schools? If more, In what ways?
  - Is there anything about the principal that makes a difference to professional development and change?
  - What was you predecessor (the ex HOD maths) like in terms of professional development?
  - Do you have a job-description? If so, Does it mention professional development?
  - Are there any other school factors that seem to make a difference?

- Educational climate
  - How much do you think that the emphasis on professional development is a product of the times?
  - How does today's educational climate influence you and professional development in your department?
  - Subjects (like technology, health and transition) are cross-curriculum, would you prefer maths to becoming more cross-curriculum in the same way

Appendix E DRAFT TEACHERS GUIDE

E.0 Contents

E.1	Introduction	238
E.2	Aims	239
E.3	Responsibility for professional development	240
E.4	Rationale for development	241
E.5	Planning for development	243
E.6	Pre-planning stage	244
E.7	What's available?	245
E.8	Influences on development	246
E.9	Models for development	249
E.10	Costs of development	252
E.11	Effective models	253
E.12	Needs appraisal	254
E.13	Planning stage	256
E.14	Implementation and application	257
E.15	Getting started	258
E.16	Presentation and modelling	259
E.17	Practice and trialing	259
E.18	Feedback and reflection	260
E.19	Support and assistance	262
E.20	Evaluation stage	263
E.21	Looking ahead	264
E.22	Further reading	265
E.23	Other references	265
E.24	Response sheet 1	266
E.25	Response sheet 2	267

E.1 Introduction

Title page

Mathematics Teachers Guide – Draft Edition

PROFESSIONAL DEVELOPMENT: designing programmes for high school mathematics teachers

Andy Begg

Centre for Science & Mathematics Education Research
University of Waikato

Aims

This guide is to help you as a mathematics teachers gain insights into the professional development process, to construct programmes that are relevant for you and your colleagues, and to move you towards more autonomy.

I have developed this guide as part of my research and wish to investigate its usefulness.

Background

As a former head of department and a curriculum developer, and now as a researcher I have found that people are the most important factor in all development work. School, resource, and curriculum development projects are only successful if they are linked with the personal and professional development of individual teachers.

Professional development is something that each teacher must be involved in - this includes considering your needs, making decisions about how development will occur, and evaluating its effectiveness. The role of the head of department and the professional development coordinator is important but is facilitative rather than directive. The role of this guide is similar, it is meant to aid development by helping you consider possibilities but not take control away.

Defining development

Staff development, staff education, teacher development, teacher education, teacher change, school development, and in-service education are all terms used in the literature to describe professional development. Most schools seek professional development that results in teachers changing some aspects of their ideas and practices in schools to improve (mathematics) learning. This guide accepts this as the main focus of professional development but extends the concept to include personal growth that has, or may have, the potential to be a positive influence on student learning and school spirit.

How to use this guide

This guide is not a step-by-step manual. It does not list development needs because full involvement by each teacher with the development process transcends such identified needs. The guide is designed to be read from cover to cover to provide an overview and then used as a reference and for further reflection. Space has been left on each page for the reader to add comments.

E.2 Aims

Specific aims

This guide has three main aims:

- to encourage the development of the teacher as an autonomous person;
- to help ensure that professional development activities are part of a planned programme; and
- to raise awareness of components of professional development programmes that make them more effective.

Autonomy and support

As teachers we must take responsibility for our own personal and professional development. What we want may differ from what is perceived by the school and our colleagues but it is important in terms of empowerment (rather than deskilling) that we pursue those we identify as being relevant. This responsibility for self does not negate the importance of support during the change process and we should seek a colleague or buddy for this.

Mismatch

From time to time, a range of professional development activities are made available. Often the needs of teachers and schools are not met by these activities even though the participants find them enjoyable. With limited resources we should ensure that there is a match between activities and requirements.

Helping the change process

My research identified some important components of development projects. Other researchers (Bolam, 1987; Joyce and Showers, 1980; Guskey, 1986; Fullan and Stiegelbauer, 1991; Bell, 1993a) also identified components that make development programmes more effective, particularly when the aim is to change practice as well as ideas. These components include: presentation of ideas and modelling; trialing and practice; reflection and feedback; assistance and support and they will be described more fully in sections 16, 17, 18, and 19. Programmes for development should be modified if necessary to ensure that they contain these components.

Points to ponder

- Do the three specific aims at the top of this page fit with your ideas, do they conflict, or are these not your main concerns?
- What is your meaning of the term 'professional development'?
- What is your first reaction to the components:
  - presentation of ideas and modelling
  - trialing and practice
  - reflection and feedback
  - assistance and support?

E.3 Responsibility for professional development

Change

One thing we know about change (both student's learning and teacher's development) is that individuals can only change themselves, the desire, direction and speed of change are all determined by the learner. While others can encourage change, the responsibility for personal change rests with each individual.

Restructuring

The restructuring of the administration of the New Zealand educational system has seen control of some aspects of education moved from the centralized Department/Ministry of Education to schools. Professional development is one such aspect.

At present the Ministry provides national curriculum documents and, through the contract system, some professional development. Schools are funded to provide further development opportunities and have an obligation through their charters to make adequate provisions.

Thus restructuring has resulted in the school, the mathematics department, and the individual teacher having much greater responsibility for professional development activities.

In-schools organization

In schools professional development is looked at from three points of view—those of the school administration, the mathematics department, and the individual teachers. The administration (Board of Trustees, Principal, professional development committee) will have in mind the school charter and other policy and budget decisions relating to professional development; the mathematics department has to consider needs associated with the learning of mathematics in the school; individual teachers have their perceived needs and ideas about how these might best be met.

The organization of professional development in a school usually rests with the principal, a professional development coordinator, or the heads of department. In reality the responsibility rests with each teacher. The implication of this is that teachers should be concerned with their needs and assertive about expressing them, rather than allowing other people to make decisions for them. A further implication is that a shortage of funds and lack of encouragement are not enough reason to neglect development activities.

Points to ponder

- Have you noticed whether your school and mathematics department are taking more control of professional development activities?
- What are you doing to ensure that your personal professional development needs are being met?

E.4 Rationale for development

Introduction

For all of us learning is a natural part of life. It occurs in various areas and the two that concern us are personal and professional growth. Learning is not something that other people do to you, it is something that you do when you want to.

Learning involves change and each learner brings a wealth of ideas and experiences that influence the learning situation. With adults these ideas and experiences tend to be fairly firmly fixed in the mind so that changing ideas and practice can be difficult.

What do you want to learn or change

New curriculum documents, visiting speakers at conferences, and courses give you ideas but the decision about what is the next item on your change agenda is in your control. That is not to say that external pressures such as a new section in a syllabus might influence what you put on your agenda.

If you are unfamiliar with some content then you may want to focus on that, if you are applying for new positions then there may be new skills to be learnt, and if you are a typical confident classroom teacher then you may want to broaden your repertoire of teaching skills. The section on needs appraisal (11) may help you to decide what to improve next.

Why change?

There must always be a reason for change — it may be for personal satisfaction, it may be to do a better job for your students or it may be reduce the stress that you find in your job. Unless some pay-off exists then we all resist change.

For most teachers the reason to change is a combination of factors. Sometimes teachers see things in classes that they believe could be improved. Sometimes a curriculum document stimulates change. Sometimes personal advancement is the spur, although the pay-off here is usually a long term one. Another reason is pressure from others, but this often causes resentment (Claxton, 1989) and is less likely to result in the desired outcome.

Points to ponder

Think about your previous experience of change.

- What initiated the change?
- Why did you change?
- What was the pay-off?

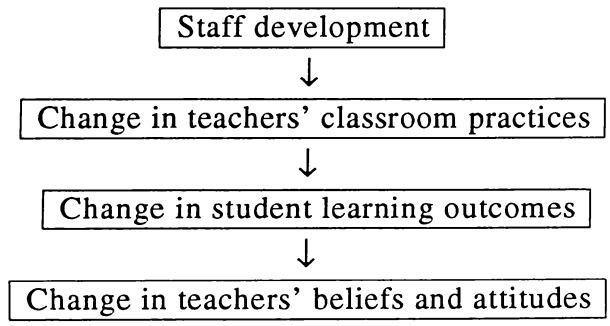
What comes first

Traditionally developers tried to change teachers' beliefs about an aspect of teaching on the assumption that such a change will lead to changes in classroom behaviour and practices which in turn will result in improved student learning.

Guskey (1986) said that the three major outcomes of staff development are changes in the classroom practices of teachers, change in the beliefs and attitudes of the teacher, and change in the learning outcomes of students. He felt it was important to the change process to consider the order of occurrence of these outcomes.

He concluded that the relationship between these aspects is very complex but suggested that convincing people about an innovation and then expecting them to do it is not the way to go; rather encourage them to try out an innovation to help them become committed to the innovation, and then work on changing the teachers classroom practices. This change is likely to lead to changes in student learning outcomes which will in turn help move teachers' beliefs and attitudes. This view of change is summarized in the following figure.

Figure 1



This suggests that rather than be based on the lecture model, it is important for courses to be organized with time and opportunities for teachers to try out innovations and then come together to discuss, share their findings, support each other, and prepare for further trialing.

Points to ponder

- In your experience of change, what came first, change in practice or change in belief?
- How much do you notice improvements in student learning outcomes? And what is your reaction to them?

E.5 Planning for development

Stages of development

Professional development is an ongoing cyclic process Stages that are evident in the planning process are outlined in this chart and then explained more fully.

Pre-planning stage (see §6)
- Collection of details about
  - school policies and budgets
  - external pressures for change
  - rationale for development (see §4)
  - what's available (see §7)
  - models for development and influences on development (see §8-§10)

↓

Needs appraisal (see §12)
- discussion of school needs
- discussion of subject needs
- discussion of individual teacher needs

↓

Planning stage (see §13)
- Decisions regarding
  - models for development (see §11)
  - focus for development activities
  - timing of development activities

↓

Implementation and application (see §14)
- Getting started (see §15)
- Presentation and modelling (see §16)
- Practice and trialing (see §17)
- Reflection and feedback (see §18)
- Support and assistance (see §19)

↓

Evaluation stage (see §20)
- Formative assessment of activities
  - consideration of next stage (continue or change focus)
- Summative assessment of project
  - future development activities
- Report for Principal &/or Board

↓

Looking ahead (see §21)
- Plan for the following year
  - repeat the cycle
  - return to preliminary stage

Points to ponder

- Are there any other factors that should be considered in your particular situation?

E.6 Pre-planning stage

Timing

Planning for a department or for yourself may take a full term so plan to begin early, perhaps in the third term of a year.

Background information

Background information may have to be collected and this should be done cooperatively. Staff should have discussed why this information is wanted and be aware of the content of it so that they can participate fully in the planning.

Required information

This includes:

- from the Ministry or other agencies
  - new (or draft) curriculum documents
  - new teacher guides
  - new assessment procedures
- from the school
  - charter statement about professional development
  - school policy statement on development (or development plan)
  - budget information (or forecast based on current year)
  - likely changes in the school population
  - details of current professional development activities
- from the mathematics department
  - strengths of new staff
  - new issues to be discussed
  - new resources being used in schools
  - new (or intended) courses being introduced
- from consultation
  - feedback from students
  - suggestions from non mathematics teachers
  - suggestions from community groups
- from professional development activities
  - ideas from meetings, courses and other schools
  - ideas from mathematics associations or networks
  - other ideas from professional reading
- and ideas associated with
  - rationale for development (see 4)
  - what's available (see 7)
  - models for development and
  - influences on development (see 8, 9 & 10)
  - needs appraisal (see 12)

Points to ponder

- Is there any other information which should be collected with the above—perhaps some specific ideas related to your school, your department, or you as an individual?

E.7 What's available

Introduction

Many development activities are available but some are not recognized as being part of professional development. Activities to be kept in mind during planning are:

In- School

The six main types are:

- meetings - staff, department (not the meetings for administrivia);
- development projects - scheme writing, resource writing, and assessment planning;
- problem solving - action research projects, and professional development cycles;
- professional development library - journals, books, and new resources;
- buddy systems (peer tutoring/supervision);
- structured in-school courses with advisers or other leaders

Local

A further three are:

- one day courses - teacher only days, local in-service meetings;
- network groups - mathematics associations, Equals networks, bilingual teacher networks, head of department groups;
- experts and courses organized by them - advisers, consultants, and providers working on Ministry contracts

Regional

The main activity is:

- personal study (by classes or correspondence) for higher qualifications such as the units for advanced study by teachers, university or other tertiary education

National

Four possibilities are:

- week long courses - teacher refresher courses
- conferences - subject associations, union groups
- teacher guides - from Ministry or associations
- texts and other resources - produced commercially or by associations

International

The main two types are

- conferences such as the Australian Association of Mathematics Teachers, the International Congress on Mathematical Instruction, or the International Conference on Teaching Statistics
- printed matter - journals, texts, conference proceedings, etc

Other

From time to time groups of teachers are engaged in projects such as national syllabus developments, changes in assessment, or collaborating in a research project. Although these are primarily intended to produce an output they are professional development opportunities for the people involved.

Points to ponder

- Are there any other professional activities available in your region?
- Which of these activities are available, could be available, and should be available for you and your colleagues at your school?

E.8 Influences on development

Research findings

My research (Begg, 1991b), overseas work (Fullan and Stiegelbauer, 1991) and work in New Zealand in the context of science education (Bell, 1993a) have identified a number of factors that influence development in a positive way, these include:

- understanding the change process;
- adequate time;
- adequate resources;
- ownership;
- numbers of people (not too few and not too many);
- modelling of new skills; and
- support and assistance

Some other factors such as leadership, locality and career stages are also influences but these may not be so easy to alter.

Understanding the change process

The change process is facilitated when participants:

- have an overview or sense of direction of the change,
- know that change takes time – 2 to 3 years for a major innovation,
- understand that trying out new strategies and finding that the risk is worth it is usually followed by a deeper appreciation of the ideas underlying the innovation,
- know that anxiety and stress is often an accompanying but temporary experience during the process (Claxton, 1989),
- are able to accept constructive criticism from a supportive but critical friend.

Time

That time is required for development is obvious. Depending on the innovation the whole process may span a considerable time. Time is wanted between sessions to try out new ideas and to reflect. Time is required with colleagues to consider new ideas and to see how they link with existing ideas and experiences.

Resources

Resources may be wanted for some innovations. Often existing resources can be modified but usually some new ones are also required. I believe that a shortage of resources is often used as an excuse rather than a reason for not changing.

Ownership

You should be involved in all stages of a project. Having a desire and a commitment to change is the first step and ownership of the project grows with your involvement in planning and as the group retains control through the later stages. Your ownership increases the closer the project is to your work place.

Numbers

You may wish, because of your situation and needs, to plan your professional development alone, this can be successful but most teachers prefer to work in a group where support and assistance is easier to access.

A 'critical mass' of people involved in an innovation seems important. It is difficult in very small groups for people to brainstorm ideas and for participants to find like-minded peers to whom they relate easily. On the other hand when the group is too large, some individuals may dominate unless the group is facilitated well.

The size of a project is usually determined by the number of volunteers who want to be involved. If the number from a school is too small it may be wise to link with neighbouring schools. When a number of schools work together the organizer may ask for two or three from each participating school to ensure that they will have support. Interactions are often improved by having a mix of primary and secondary teachers.

Modelling

Participants in a course often want to see what they are expected to do. The provider can model the practice or show a video to illustrate what could occur. If the new strategy is not modelled then the participants' interpretations could well be different from that intended (see §16)

Support and assistance

Claxton (1989) and Claxton & Carr (1991) have written about change being both an emotional experience and an intellectual one.

Project participants require feedback from colleagues as well as students and want support in dealing with this feedback. They seek assistance and support in continuing their endeavours (see §19).

Leadership

Leadership is likely to influence the success of a professional development project. The interest and support of senior staff is important. When this is not forthcoming it may be desirable to have a supportive outsider involved.

Projects that lack leadership from the top will be successful if participants develop a strong group identity and commitment to see the project through.

Locality

Usually it is better to run a project close to your work situation rather than at a 'neutral' locality so that you can try out strategies easily. Time and resources for travel and accommodation can be minimized by having a course on site but this is not always practical when you are working with people from different schools.

Career Stages

The needs of different people change according to their career stages and life situations and course organizers should take this into account. For example, family responsibilities may limit the amount of time and the time of day that some teachers can devote to professional development activities, and some teachers late in their careers may feel that they do not have the energy to commit themselves to major change.

Levels of impact and components

Some interesting work by Joyce and Showers (1980) identified four levels of impact of development activities:

- general awareness,
- organized knowledge,
- learning of new skills, and
- application on-the-job

and five components of these activities:

- presentation
- modelling
- practice
- feedback and support, and
- assistance.

Bolam (1987) considered the links between these levels of impact and components. The matrix represents a summary of his thinking.

Matrix 1

Components required to achieve the levels of impact

Levels of Impact	Component of development activities				
	Presentation e.g. lecture	Modelling	Practice, real or simulated	Feedback & support	Assistance
General awareness	√				
Organized knowledge	√	√			
Learning of new skills	√	√	√	√	
Application on-the-job	√	√	√	√	√

Implications from this matrix

This matrix indicates how different components are required to achieve the desired level of impact. Models should be chosen because they include appropriate components or modified so that they do.

To illustrate this point, in mathematics education many of the needs perceived by teachers, educators, and policy documents are related to teachers teaching differently to incorporate the use of more open-ended learning activities and relevant technology. This means that application on-the-job is the relevant purpose and all the five components are required. While the first two components can be presented at a lecture or through a teachers guide, and the third component can be managed at a workshop session even on the same day, the final two mean that support from colleagues should continue for some time afterwards. This is often overlooked.

Teachers guides, lectures, and conferences are fine for talking about new content and new courses but are not adequate when teachers want to move towards implementation, try out new skills, and change their classroom practice. For these to occur the additional essential elements are time and support which includes assistance, feedback and reflection.

Summary

To make the most of a professional development project the participants should have the opportunity to modify it to enhance the positive influences and minimize the negative ones. This will often involve compromises.

Points to ponder

- From your experience, what components of development activities have caused you to change what you do in the classroom?

E.9 Models for development

Introduction

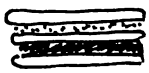
The models listed in this section are a chosen from the range of possibilities. Overlap exists between them, for example a structured course may use an adviser and also be organized as a school cluster course. In this section these models are considered in relation to the influences listed in the last section.

One-shot courses



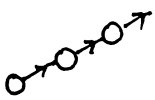
One-shot courses may include teacher only days, conferences and one-week courses . These should be viewed as either information updates or advertisements. We know that very little can be achieved in one day but such a course may raise teachers' awareness about relevant issues. With week long courses the participants may see new ideas and get some hands-on experience, but in virtually all cases they will not be able to try these ideas with students. Such courses must be considered as the starter stages for longer term projects and should be organized with this in mind.

Sandwich courses



A sandwich course comprises two or three days with time sandwiched between the days so that specific agreed activities can be tried in the classroom. Sandwich courses improve on one-shot courses but may lack time for ownership and support to develop.

Structured courses



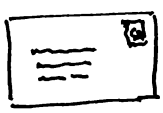
A structured course is usually an organized one over some fixed time frame (perhaps 10 weeks). The content is often pre-organized (as distinct from action-research courses where content emerges). The content may have been chosen to match identified needs and the time allows for strategies to be tried and ownership and support to develop.

Study courses



These may involve attending lectures or be by correspondence, Traditionally they involved individuals but it would be more productive if small groups of two, three or four were encouraged to be involved together. The courses may focus on content or be practically oriented and require trying ideas in the classroom.

Postal Models



Teacher guides, journals, new texts, and other resources often arrive in the mail, often as a result of one person ordering them. They usually offer a range of ideas but these will only be taken up with commitment from the department. Expertise received through the post provides starting points or useful inputs to professional development but to be successful these should be followed by discussion, experimentation, feedback and support.

Adviser/ consultant



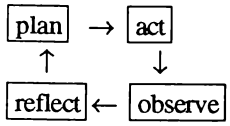
The advantage of having advisers or a consultants at a course or involved in a project is that they may bring in a new perspective. They are more likely to offer a design solution which involves a new approach to an old situation rather than an efficiency solution which simply makes old practices more efficient. Care is required so that the group does not become dependent on the expert.

Project-based



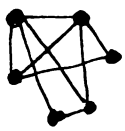
Project-based activities focus on particular issues of concern. They may be scheme writing, assessment planning or worksheet production. They can be organized in a number of ways but again trying out ideas and getting feedback should be incorporated where appropriate.

Action-research



A number of action-research models for development occur in the literature. Problem-solving projects and professional development cycles are two common forms of this type of activity. They focus on areas for change identified by the participants and involve a cycle of planning, collecting data, trying strategies, getting feedback, modifying plans, and continuing on the cycle.

Networks



Mathematics associations were formed to provide networks for people with similar interests. Other formal and non-formal networks have been formed to support and link people with similar interests. Some examples are: Equals, bilingual mathematics teachers, Pacific Island mathematics teachers, heads of department, alternative courses, beginning teacher networks, and family maths. These groups often organize professional development activities and seem to stress trying out ideas, reporting back, and providing mutual support.

Organizational features

The above models focus on aspects of time, expertise, and activity. The next two relate to the locality of courses and are possibilities with all the previous models.

In-school



Ideally all of a department would be involved in any departmental project. Some in-school projects might be cross-curricular, in which case only some of the department might participate. While there are advantages to do with the department moving together, a department-only project can have disadvantages, these might include:

- a department is sometimes inward looking and lacks new ideas.
- a department often has an established pecking-order and younger teachers may feel that they are expected to know their place, and
- teachers do not always disclose readily about their successes and failures with colleagues whom they see every day.

School cluster groups



Cluster groups are valuable when teachers from a number of small mathematics departments get together to form a more viable group. This increase in number increases the range of different ideas and the resources that might be shared. Cluster groups are essential for projects when the department is looking at the interface between schools (for example Form 2/3).

Summary

The models described in this section can be considered alongside the components to find if they are **potentially** effective or whether they should be modified. This matrix shows the potential but in any particular course components may not be present.

	Presentation of ideas	Modelling of practice	Practice & feedback	Assistance & support	Adequate time	Ownership
One-shot courses	√	√				
Sandwich course	√	√	√			
Structured courses	√	√	√		√	
Study courses	√				√	
Postal Models	√				√	
Adviser/Consultant	√	√	*	*	*	
Project-based	√	√	√	√	√	√
Action research	√	√	√	√	√	√
Networks	√	√		√	√	√

* Probably too expensive to have visiting frequently

Deficiencies and modifications

It is clear from this matrix that most models have limitations. This is not to say the models should be ignored. In cases where new ideas only are required they would all be suitable. In other cases a few models might be the only help available or they may be the only affordable ones.

Each of them can be modified and missing elements (particularly practice & feedback, and assistance & support) provided by colleagues in a school.

The development of ownership depends on how a course is set up and whether its focus is participant-identified topics or ideas from some external source.

Points to ponder

- Have you experienced any other types of development activity?
- Can you think of any other models that could be considered?

E.10 Costs of development activities

Limited resources

We all have limited time, money and resources for professional development. Therefore we have to consider the cost-effectiveness of the models.

Actual costs

The financial costs are straight forward. For budgeting purposes, the following table provides some guidance.



Teacher relief	
One teacher relief day	$200
One hour of teacher relief time	$40
Consultant	
One day	$500
Travel	
Total cost	$1 / km
Running cost	50c / km
Venue hire	$50 / day
Full accommodation	$120 / person / day
Meals (lunch and teas)	$20 / person /day
Study fees	$400 / paper
Journals / guides / texts etc	$10 to $100 each
Course materials (xeroxing etc)	est $5 / person

Faced with such costs one can understand why policy makers and schools prefer courses to be after school or during vacation.

Nominal cost

The nominal costs include the above costs whether they are actually paid or not. For example, if you work for two hours in the evening then the nominal cost is $80 as this is what your time is valued at. In designing a programmes we should be careful to spread the load equitably and ensure that the nominal costs borne by participants are not excessive.

Project proposals

When preparing a proposal it is sensible to include nominal costs borne by you as well as those paid for by the school or other parties. A board would be likely to prefer a proposal for $5000 if they were being asked for $2000 and the teachers were to bear $3000 compared to one where the only figure given was $2000 and they were asked to pay it all.

Cost effectiveness

Obtaining a measure for effectiveness is difficult . The ideas of effectiveness and cost effectiveness will be considered in §11.

Points to ponder

- Accepting the political/economic environment, what is a reasonable balance for costs from the ministry, the school, and the individual?

E.11 Effective Models

Criteria for effectiveness

The long-term aim of teacher development is to improve the learning outcomes of students. This is difficult to measure and even harder to analyze in terms of which inputs caused which improvements. An alternative to this might be based on some 'indicators' of learning but again it is hard to determine what should be looked at to decide if learning is occurring.

Similar problems arise if the criteria to judge models is based on changes in teacher practice because these are not always caused specifically by the development activity.

Because of these problems, together with the fact that choosing a model involves making a decision before rather than after the event, it may be more reasonable to consider the potential effectiveness of models.

Potential effectiveness

The criteria for potential effectiveness are based on the research that suggests that specific components should be present in models if they are to be successful.

For projects aimed at raising the participants' awareness of new ideas, the only essential components are the presentation of the new ideas and time for the participants to discuss and reflect on it.

For projects where the aim is to change the practice of the participants, the necessary components that one can provide are:
- presentation of the new information
- modelling of new practice
- practice & feedback (including reflection)
- assistance & support
- adequate time
- ownership

From my research I would say that none of these should be omitted and if any are omitted then it is likely to significantly reduce the effectiveness of the programme.

Cost-effective

A guide to the potential cost effectiveness of a model can be obtained by considering the budgeted cost of the activity alongside the potential effectiveness. While the cost is simple to calculate, a measure of potential effectiveness is harder to assign. One method of assigning such measures is based on 'best guesstimates' by experts who might suggest the influence of each component. Alternatively you might start with a number such as 100 for potential effectiveness and discount it by (say) 25% for each missing factor.

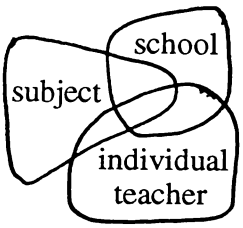
In practice the teachers concerned will consider their own experience and assign their best 'guesstimates' or 'discount' rates for this purpose.

Points to ponder

- The two factors that improve the cost effectiveness of development activities are an increase in effectiveness and a decrease in costs. Are you aware of other ways that these two factors can be influenced?

E.12 Needs appraisal

Introduction



My research (Begg, 1991b) has shown that there are three main foci for professional development – the school, the subject, and the individual teacher. The needs of these three overlap.

Teachers, departments and schools are under pressure and do not like to be criticized personally. Considering school and subject needs before individual needs provides a non-threatening way into looking at professional development needs within a department.

Needs appraisal is diagnostic assessment, as with all assessment one guiding principle is "if the results are not going to be used then do not assess". Thus if resources do not exist to ensure that development activities occur then appraisal procedures should not begin as they are likely to be misinterpreted by teachers. If an action-research model is being used then the needs appraisal is incorporated in the cycle.

Needs appraisal

Appraising needs involves finding areas on which to focus development. It is **not** a review of the school, the department, or an individual's performance. If professional development is to be based on what is being offered rather than what staff want, then a staff development appraisal programme is not justified. In general a school or department should first show that it will take initiatives in planning professional development rather than only being reactive before it commences an appraisal programme.

Needs appraisals take time so a school that intends to respond to identified concerns should commence the appraisal process some months beforehand. Term 3 is probably a good time to start planning for projects in the forthcoming year.

School needs appraisal

School needs can not be decided by the mathematics department in isolation but departments need to discuss them so that other needs are seen in perspective. When a department's staff discusses school needs prior to the full staff discussion then they are more likely to have a significant input as they will have organized their ideas.

School needs may only impinge on one or two in the department (e.g. middle management training) or they may affect virtually everybody (e.g. improving the quality of form-teacher guidance). They usually focus on aims and policies of the school, management, guidance, and consultation; decisions regarding curriculum are usually left to individual departments. However some curriculum issues may have to be looked at as school needs as they are cross-curriculum issues, for example transition education, assessment initiatives, or consideration of the service role of a subject like mathematics.

Department needs

An initial needs appraisal can be done by brainstorming, informal discussion and survey sheets. It is important that the identified needs are dealt with first as they are the ones the department owns.

Later appraisals may obtain inputs from students and other staff as well as from the department.

New curriculum or assessment initiatives, new teaching methods and learning theories, new courses in the school programme, and other external factors could be considered as areas for development and might be pushed by a head of department providing leadership.

Individual teacher needs

Finding your development needs is identifying areas of potential growth, it is **not** making judgements. If a needs appraisal began with the school or department focus rather than an individual one it is likely to have raised needs which may not be appropriate for the whole department. But these should be reconsidered when looking at the needs of you and your colleagues.

Further needs will arise during individual or small group discussions or interviews. These sessions should be supportive with an emphasis on growth rather than identifying weaknesses

Teachers who regard the classroom as problematic and reflect on the events that occur in it will have already identified areas for change.

Teacher Roles

When looking at teacher needs, it is useful to consider the range of roles that every teacher performs, as these influence development needs. These roles are not pretences but are aspects of what a teacher must be. During the school day they typically include:

- teacher as person
- teacher as behaviour manager
- teacher as learning facilitator
- teacher as listener
- teacher as learning manager
- teacher as subject specialist

(teacher as teacher)

- teacher as pastoral caregiver (guidance role)
- teacher as colleague (support role).

Some teachers also take on additional roles in the school such as:

- teacher as extra-curriculum expert (sports coach, etc)
- teacher as middle manager (head of department, dean)

Other roles are occasionally taken on by teachers as part of their outlook on life, for example:

- teacher as change agent (developer)
- teacher as researcher (enquirer)
- teacher as valuer of traditions (conservative).

Career possibilities

One aspect of needs appraisal is related to career planning. You should consider your career and aspirations, and those of your colleagues, in planning for professional development. Likely options might include:

- subject specialist (HOD, adviser, principal, review officer, ...)
- guidance specialist (dean, careers teacher, counsellor, principal ...)
- administrator (HOD, dean, senior management, principal, ...)
- other options within education (teacher training, public servant, ...).

Ages and stages

Some career stages with specific development needs that you may identify with are:

- beginning (induction)
- re-entering the profession
- increasing competence and becoming creative
- changing schools or changing position (within or outside the school)
- declining competence
- nearing retirement

Points to ponder

- Where do you see yourself?
- Where do others see you?
- Where do you want to go?
- How do you want to grow?

E.13 Planning stage

Decision time

Your school will have policies on development. If further decisions are to be made, then department members should be involved as this helps develop ownership of projects which is important if compromises from individual choices are made. These decisions are likely to involve priorities, models for development, detailed plans, and budgets.

Priorities may be influenced by:
- external pressures such as new curriculum documents;
- preference for personal growth experiences relevant to individuals;
- what resources are known, or are likely, to be available;
- other factors identified in the pre-planning stage.

Modifying models

Models may have to be modified to take into account what is known about effectiveness. In particular, time, opportunities for practice (trialing), feedback, assistance, and support must be provided.

Focus for development activities

Beginning teachers and newly-appointed middle managers have special needs but the main development focus is likely to be on how teachers teach. This arises from research on learning by mathematics educators and the content/process debate. Such changes were signalled in the 60s with 'new maths' and although the content of mathematics and the clientele in schools has changed, teaching is still dominated by teacher talk and drill and practice.

Timing of development activities

When teachers want to make significant changes to practice, development should be spread over time. A ten-week programme with a weekly meeting would be the minimum required. More time is preferable if teachers are to be confident in doing the new activities, but participants may want some breaks if the programme runs all year.

The law of diminishing returns suggests that it is more effective to put time and effort into big changes and get some action rather than spend time on small details or making sure that implementation is complete.

When teachers see their work as problematic and experience satisfaction by changing their practice, they usually want to keep growing and being involved with other change – this has implications for time.

One quotation "it is more important to have a map than an itinerary" reminds us that there is more than one way to go from A to B and that speed is less important than direction.

Cooperation

Cooperation and joint projects with other departments (and schools) should be considered as many topics such as assessment, interactive teaching, and problem solving arise in many subjects.

Ownership

Initially ownership of a programme starts when participants identify the needs and begin to plan. During the project they should retain control of what is being considered and the rate of change and they should spend time discussing their concerns with others in the group. To help this it is worthwhile to encourage the keeping of journals that document activities and thoughts, otherwise shared time can be spent on anecdotes rather than actual behaviours and feelings.

E.14 Implementation and Application

Implementation and application

Implementation can be interpreted in two ways. It might refer to implementing a professional development project or to implementing the new skills learned during the project and applying these in a range of situations beyond those discussed during the project. This long-term desired outcome could be called application.

RDD model

Historically development was based on the research, development, dissemination (RDD) model for change. This was a top-down or centre-periphery model where direction was provided from a central authority and the product rather than the process was the important issue. Such a model was linear and can be represented as:

Research	research identifying areas for change
↓	
Development	central curriculum & resource development
↓	
Dissemination	teacher development & change implementation

Thus implementation in the RDD model is the final stage of a process and the only stage in which teachers are all involved.

IC model

The components suggested in this guide imply a more interactive and collaborative model (IC) in which the research, development and dissemination stages are much more intertwined. The participants collaborate and are in control, it is a grass roots initiative. There is some interaction between the centre and periphery but it is in both directions, and development is seen as a process rather than in terms of products.

The IC model is cyclic rather than linear and might be represented as:

introduction to new ideas		presentation modelling, awareness
↓	↑	
learning new skill	↑	trialing, practice, feedback, reflection,
↓	↑	support and assistance
application on-the-job		alter scheme & apply to other situations

In this model the identification of specific changes and the action research involved in trying out new skills are the initial part of the teacher-led implementation. If the other components are present then the longer term application commences and the changes start to be applied on-the-job. Finally the new practice becomes a part of the teacher's regular teaching repertoire and is transferred to numerous different situations.

Points to ponder

- During the planned implementation are opportunities for practice and feedback adequate?
- How can you ensure that support and assistance continue until application is achieved?

E.15 Getting Started

Advertising Teachers are made aware of professional development activities that are available through advertisements. These might be brochures or lists of courses but also include one-shot 'tasters' which strike a sympathetic chord. Other ways of helping teachers become aware of innovations are by circulating articles or resources, by discussing possibilities at department meetings, and by following up a needs appraisal.

Motivation At the start of a professional development activity the teacher is likely to want to learn. If the planning has been done well then motivation will not be a problem, if not then the head of department might want to spend time cajoling or pressuring people into participating. This is not likely to be successful as people will only change if they want to – it might be better to concentrate on volunteers.

Start where the teachers are In considering any learning situation the first requirement is to find what the learner brings to the classroom and what they want to learn. Professional development is no different in this respect. The participants bring lots of experiences and ideas to the situation and these will influence the directions in which they want to grow.

The initial stages of meetings ought to provide sharing time for appropriate experiences to be considered by all the participants or in smaller groups if the large group is either too large or too disparate.

Change process Understanding the process of change is important and time should be spent explaining the way that the professional development programme will proceed and the desired effects (Fullan and Stiegelbauer, 1991).

Anxieties Anyone undergoing change must be made aware of the anxieties and insecurities that arise for us all when we begin to take risks (Claxton, 1989). Knowing that these feelings are common and temporary helps.

Learning or teaching While the focus of professional development is to improve student learning, teachers often think of their teaching first, as this is what they have most control of. The preliminary focus could therefore address the things that the teacher does, rather than what the student does.

Communication When a major development activity is begun, the administration and the school community should be aware of it, as this is likely to lead to more understanding, support and assistance.

Collaboration with students The students in your classes are important; they are young adults with rights and generally they respond well to being treated as adults. If you want to try new strategies with them then they have a right to know what you are doing and why you are doing it. Sharing your experiment with them usually has a positive side as they are often keen to try new activities and will tell you about the success or otherwise of the trial.

Points to ponder

- What is your source of ideas for development activities?
- Is the innovation you are planning big enough to tell the school community about?
- How would your students respond to being part of your experiment?

E.16 Presentation and modelling

Presentation of ideas and modelling

If new ideas about teaching are being presented then it is appropriate for a presenter to model them when presenting the information. This may not be in quite the same way as one would with school students but the parallels should be obvious. For example, if the presenter wanted to show a strategy for teachers to find out students' alternative ideas about fractions, then the presentation might start with this method of eliciting their views being applied in terms of teacher's alternative views of learning. The presenter might then offer some suggestions about how this idea could be implemented in class.

Classroom visits

Classroom observation through visits or through team teaching offer further opportunities to see how new material can be presented with appropriate teaching strategies being modelled.

Videos

A video recording is another alternative that can be used. It is particularly useful when discussion starts as the action can be replayed for analysis.

Mind-plays

Teachers are imaginative and can usually visualize some possibilities without actually seeing them. If other resources are lacking then a brief description of a strategy followed by time for teachers to think about it, jot down some ideas, and discuss what they imagined would happen would be a useful starting point.

Points to ponder

- What other ways would you use to present new ideas?
- In an in-school group without an outside consultant, how would new ideas be presented?

E.17 Practice and trialing

Practice

Practice sessions may be in simulated situations with colleagues, in micro-teaching situations with a small group of students, or in real whole-class situations.

Having seen or heard about some new ideas it is important that participants in programmes have an opportunity to try these ideas for themselves. At a course this may happen with a hands-on-workshop or the organizer might arrange a role-play activity. If the programme is in a school situation then it may be possible to split a class and use them for micro-teaching in the first instance.

Trialing

After the initial practice run it is important to try the new idea in a normal class situation. This should be viewed as a trial, after the feedback comes in the trial is considered and you have time to reflect on whether modifications will be required.

Follow-up

If the trial is successful and the programme participants have shared their ideas about it then changes will be made in the school scheme to ensure that it is incorporated later. The other aspect that should be shared is a consideration of ways that the same innovation might be applied to different situations.

Points to ponder

- Would you prefer to first try a new strategy with your own class, with a class that you were unlikely to see again, with a small group of students, or with a group of colleagues in a role-play?

E.18 Feedback and reflection

Feedback and reflection

Feedback is information about a process or experiment that may suggest that modifications would be desirable. Reflection is one way of getting feedback. Reflection takes three forms:, reflection-for-action, reflection-in-action and reflection-on-action, they differ in when they occur. The main purpose of reflection is to uncover assumptions.

Who provides feedback

Whether the main source of feedback is from a critical friend, a peer, or a head of department is something that you will decide. Students can often be relied upon for good feedback too and individual teachers may feel that their own reflection on the change process is sufficient.

Action research

If data is collected from an action research activity this provides a focus for reflection.

Using a critical friend/buddy

Having a buddy in the same school is desirable but not always possible. A friend from another school or a sympathetic partner at home may be happy to discuss any feedback that you have.

Students

Interacting with students, asking them questions and listening to their full responses are ways that teachers get feedback. The questions should be about ideas rather than be procedural ones (not "have you got the answer yet?" but "what do you think about that idea?"). Responses that tell you what students are thinking are the most valuable.

Surveys, the post box method, and other data collecting systems are formal ways of getting feedback from students. Less formal methods include the students' comments about lessons and how they feel about them. These may address better learning but often are only about learning conditions such as being busy, happy, interested and task oriented. These conditions are necessary but not sufficient for better learning, so one may want to probe further.

Journals

Journals (not just diaries) are useful for the recording of feedback and they provide a focus for further reflection in a way that oral feedback does not. Journal options include teacher-journals, student journals, and class journals.

Writing in journals may be descriptive, cathartic, or reflective but all are useful to reflect on later either privately or when the journal is used with a critical friend as a professional conversation.

Class journal items can be raised with a class to provide more feedback. If you are using student journals then class time should be provided for them.

Giving and getting criticism

It is sometimes hard to criticize and even harder to accept criticism. One way to make this easier is to ensure that you always criticize something rather than someone and when negotiating with a colleague for feedback, be specific about what behaviour or practice you want them to respond about. Many of the assertiveness books written in the 60s have chapters on giving and receiving criticism and if you feel insecure about this then they are worth reading.

It is important to accept that problems exist for us all, we want honesty and not smooth-talk, because the reason for asking for support is to get data on which we can build.

Reflection	Reflection does not come naturally but is a learned behaviour. It aims at getting you to think about your thinking. It is often helped by you conditioning yourself to ask yourself questions.
Reflection-for-action	Reflection-for-action has traditionally been thought of as planning but as well as asking "what will I do?" and 'how will I do it?" you should ask "why am I doing it?" and "what am I assuming?"
Reflection-on-action	Reflection-on-action is an evaluative type of reflection. It is part of reconceptualizing teaching. The traditional questions of "how did it go?" and "did the children really learn it?" should be supplemented by "how did I feel trying those new strategies?" "what was it like in that different role?" "how do I know that the students really learned it and were not just kept busy?" and "if I had done it differently would it have been better?" Another question might be "was I like the teacher that I would like to be like?"
Reflection-in-action	Reflection-in-action is uncovering assumptions while you are working. It is usually the last type of reflection that is learned. We make decisions quickly in actual situations but rarely ask "what am I doing?" "why am I doing it like this?" "what if?" and "but, what about?"
	One way of giving yourself time to reflect-in-action in class is to ensure that when a student asks a question your response is another question. This gets the student saying more, it gives you time to reflect, and it may lead to the student reflecting on the situation.
Aids for reflection	Writing down ideas has two purposes, it clears your mind, and writing a story forces you to reflect and organize the ideas. (Sustained silent writing during courses is one suggestion here.)
	Concept maps are another way of organizing ideas and linking them together.
	Thinking and writing in metaphors can be useful when reflecting as they enable you to consider parallels and gain new insights.
	Watching a video of yourself in action or discussing the role you had in a role-play provides plenty of opportunity to reflect on practice.
	Setting up a 'critical debate' where you take an unfamiliar perspective or defend a practice that you are not in favour of is another way of helping consider alternative assumptions.
Points to ponder	• There is no one way to receive feedback and reflect on ideas and activities. Identify some ways that you feel comfortable in doing these things, and be prepared to try new ways, as they might work too.

E.19 Support and assistance

Support and assistance

Support means encourage, stand beside, and take a secondary role; assist means to actively help but does not mean 'do, instead of you doing it' as that is not empowering.

Anxiety and stress

With new developments you may be stressed and feel anxious. Intellectual disorientation will be experienced if the new approach does not fit your framework of ideas about teaching and learning. At this stage excuses emerge – I won't have time to get through the syllabus, and there are no resources for this! This is part of the change experience. The anxieties can be reduced by talking about feelings and receiving support. If the group is large it may be worth splitting into cohesive sub-groups for this support.

Who gives assistance

Assistance is most likely to come from those involved in the project and from your buddy. It may also come from students and other colleagues.

Who gives support

Support can come from the board, principal, head of department, colleagues, community, and students. Support is more likely when there is open communication, personal contact, written communication, group presentations, publicity, and reporting back. The principal's role is to create and support a culture for development.

Having at least two people who get on well with one another from each school helps ensure support exists when a project is based on a cluster of schools. Support comes from networks, teacher trainees, and yourself. Networks aim to support people with similar interests and with technology, e-mail and bulletin boards mean that network support is not limited by distance. Trainees are keen to see innovative practice and when teachers project an image of 'teacher as learner' trainees give considerable support. Journal writing provides self-support .

Critical friend/ buddy

If a colleague is not available for professional assistance and support, then choose a friend, the support will be personal but still valuable.

External support

The status of a development activity increases if an outside expert is involved or some external support is evident. However teachers prefer to hear about ideas that might suit their classes from like-minded peers, rather than from visiting experts.

Impediments to change

One way of helping a development is to consider what restrains it and reduce or avoid these impediments. They may be structural, such as common tests or timetable decisions or they may be opponents to the development. When opponents are identified involve them in planning as this can defuse their opposition and help change their minds.

Sharing sessions

When helping it is not sufficient to show interest, interaction and inputs that help the person reflect and make decisions are also required. Talking about the trying out of strategies from earlier meetings is one way to get support and assistance. The facilitator should ask questions that stimulate reflection to make the most of this sharing.

Points to ponder

- There are many ways to provide support and assistance. Identify ways you could support colleagues in a development in some other subject.
- Imagine working closely with a buddy (think of a particular person),
  - how would you assist and support them?
  - how would you like them to assist and support you?

E.20 Evaluation stage

Four aspects

Evaluation of teacher development is similar to evaluation of teaching. Four aspects of this are diagnostic assessment, formative assessment, summative assessment, and reporting.

Possible foci for evaluation might be:
- the teacher development process;
- changes in teacher practice in classrooms;
- indicators that better learning is occurring; or
- changes in student outcomes.

Since it is difficult to identify changes in student outcomes and decide what caused them, it is more appropriate to look at changes in teacher practice and other indicators.

Diagnostic assessment

Diagnostic assessment has already been considered in section 12 on needs appraisal

Formative assessment

Formative assessment of the change process will arise at sessions where future planning occurs. Questions will be posed to find if the necessary components are being provided and whether to change the focus for the next session.

Formative assessment of the changes in teaching practice happens during feedback and reflection accompanied by support and assistance.

Summative assessment

Summative assessment occurs at the end of a project. If the project is ongoing then it is appropriate to summarize progress at regular stages which might match planned targets. The summative assessment may be based on participants' self-assessments, feedback from others in the project, or an independent person being asked to assess progress.

Self-assessment

The difficulties in assessing specific long-term changes have already been alluded to. If teachers are encouraged to self-assess then it is possible to obtain their perceptions about whether they are achieving change. These may be based on learning indicators which are not necessarily reliable, but it is the teachers' perceptions which will cause them to proceed or to draw back – so self-assessment is important.

Reporting

The final stage of evaluation is reporting. In an environment of accountability it is politic to report to the head of department and the professional development coordinator (if they are not involved in the development activity). The Principal and the Board of Trustees have a vested interest, but staff, community and students are also entitled to hear about it.

Reporting on teacher development, like reporting on students, is a combination of formative and summative assessment and could provide some indicators of future plans as well as references to the effectiveness and the costs of the work to date.

Points to ponder

- Consider the last development activity in which you were involved. Was there any diagnostic, formative or summative assessment, and did you report on your involvement?

E.21 Looking ahead

The future

In looking ahead you should first consider what has been achieved compared with what you hoped to achieve. Keeping journals during the project provides data that helps this process.

Participants may feel there is much more to be done and might want to continue the project. Alternatively you might want to return to the preliminary stage and reconsider the whole cycle.

In general this long-term planning should commence during Term 3 when planning for the following year.

You are likely to miss their support group when a project stops. It is reasonable to continue support meetings for some time so that this loss of support is gradual. In the long run, as you become more confident you will not feel the same urge for support, and your autonomy will be strengthened.

Some alternatives

Planning for the following year might consider:
- trying new methods;
- planning for a longer period; and
- planning for numerous projects at the same time (or for one project that integrates a number of smaller ones).

To obtain new ideas and new possibilities for development it is worthwhile to talk to teachers from other schools and to attend conferences and courses where different ideas will be discussed. It is also useful to subscribe to appropriate journals where a range of new ideas are often presented.

Next stages

You should see school and professional development as a natural growth process. With more positive experiences this view is more likely to emerge and your confidence will grow. You should be encouraged to identify your own needs and to take more responsibility for collaborative planning to have these needs met. Ideally teachers will be accepted as experts both in mathematics teaching and in professional development and the desire for input from outside the school should decrease. Other teachers may have a different view of learning and it may be profitable to have sessions with teachers from other subjects.

and finally

There is no "finally", the process continues ...

E.22 Further reading

Professional Development

Three booklets about professional development in the context of mathematics education are:

- New Zealand Equals Network (1989) *Mathematics Teaching: Making Changes* Australia: Latitude Publications
- Owen, John, Neville Johnson, Doug Clarke, Charles Lovitt, and Will Morony (1988) The Mathematics Curriculum and Teaching Program (MCTP) *Guidelines for Consultants and Curriculum Leaders,* Canberra: Curriculum Development Centre
- Taylor, Ross (Editor) (1986) *Professional Development for Teachers of Mathematics: A Handbook* Virginia, USA: National Council of Teachers of Mathematics Inc (NCTM)

Other Books

A number of books are not mathematics specific but are concerned with school and professional development. The following examples are very readable and are suitable for schools' professional development libraries

- Bradley, Howard (1991) *Staff Development* London: Falmer Press (School Development and the Management of Change Series: 9)
- Claxton, Guy (1989) *Being a teacher: a positive approach to change and stress* London: Cassell Educational Ltd
- Fullan, Michael G. with Stiegelbauer, Suzanne (1991) *The New Meaning of Educational Change,* NY: Teachers College Press.
- Stewart, David and Prebble, Tom (1985) *Making it happen: a school development process,* Palmerston North: Dunmore

E.23 Other References

Begg, A J C (1991b) *Professional Development of High School Mathematics Teachers: Research Report #1* (A Report to the Research and Statistics Division of the Ministry of Education), Hamilton: Centre for Science and Mathematics Education, University of Waikato

Bell, Beverley F (ed.) (1993a) *I know about LISP but how do I put it into practice?* Hamilton: University of Waikato, Centre for Science and Mathematics Education Research (Final report of the Learning in Science Project (Teacher Development) for the Ministry of Education)

Bolam, Raymond (1987) What is Effective INSET? in *Professional Development and INSET: Proceedings of the 1987 NFER Members Conference,* National Foundation for Educational Research, p38-53

Claxton, Guy & Carr, Malcolm (1991) Understanding Change: The Personal Perspective, in *SAMEpapers 1991,* p 1-14

Guskey, Thomas R. (1986) Staff Development and the Process of Teacher Change, in *Educational Researcher,* 15(5) May 1986, p 5-12

Joyce, Bruce R and Showers, Beverly (1980) Improving inservice training: The messages of research, *Educational Leadership*, 37 (5), February 1980, p 379-85

E.24 Response sheet 1 - to be sent after initially reading this guide

Please return this response sheet to:

Andy Begg
University of Waikato
Private Bag 3105
Hamilton

Name _____

School _____

Address _____

Position _____

1 What, if any, parts of this guide did you find useful?

2 What new ideas or different viewpoints did you find from this guide?

3 What topics did you want further details about?

4 What changes will you consider making as a result of reading this guide?

5 Any other comments? (Please continue on other side if you wish)

E.25 Response Sheet 2 - to be sent in term 3 1992 after starting planning for professional development in 1993

Please return this response sheet to:

Andy Begg
University of Waikato
Private Bag 3105
Hamilton

Name _____

School _____

Address _____

Position _____

1 What, if any, parts of this guide did you find useful?

2 What changes have you made in your planning as a result of this guide?

3 What topics did you want further details about?

4 Has the reading of this guide by other colleagues had any influence on the planning process? If so, in what way?

5 Any other comments? (Please continue on other side if you wish)

BIBLIOGRAPHY

Abercombie, M L J (1969) *The Anatomy of Judgement: An Investigation into the Process of Perception and Reasoning.* Harmondsworth: Penguin (cited in Nias, 1987, pp.148–9)

Anderson, Christine (1989) Girls and Mathematics, in: New Zealand EQUALS Network (1989) *Mathematics Teaching: Making Change.* Glen Waverley, Victoria: Latitude Publications, pp.5–13

Apple, Michael W and Jungck Susan (1992) You Don't Have to be a Teacher to Teach This Unit: Teaching Technology and Control in the Classroom, in: Hargreaves, Andy and Fullan, Michael G (1992) *Understanding Teacher Development.* London/New York: Cassell/Teachers College Press, pp.20–42

Appleton, Ken; Hawe, Eleanor; Biddulph, Fred and Osborne, Roger (1984) So You Think the Guide Materials Look Good! *Research in Science Education,* 14, pp.206–212

Ashley, Roy (Chairman); Edwards, Jim; Hayter, John (ed.); Shaw, Bob; South, Gerald (1988) *Managing Mathematics, A Handbook for the Head of the Department.* Cheltenham, England: The Mathematical Association and Stanley Thornes (Publishers) Ltd

Baird John R and Mitchell Ian J (1986) Lessons from PEEL: A look to the future, in: Baird, John R and Mitchell, Ian J (eds.) *Improving the quality of teaching and learning.* An Australian case study The PEEL project. Melbourne: Monash Printery, pp.285-295 (PEEL = the Project for Enhancing Effective Learning)

Baird, John R and Northfield, Jeff R (1992) *Learning from the PEEL experience.* Melbourne: Monash University

Ball, Stephen J (1990) Self-doubt and soft data: social and technical trajectories in ethnographic fieldwork, *Qualitative Studies in Education, 3(2)* pp.157–171

Baskett, H K Morris and Marsick, Victoria J (eds) (1992) Professionals' ways of knowing: new findings on how to improve professional education, *New Directions for Adult and Continuing Education,* Volume 55

Baskett, H K Morris; Marsick, Victoria J and Cervero, Ronald M (1992) Putting theory to practice and practice to theory, in Baskett, H K Morris and Marsick, Victoria J (eds) (1992) Professionals' ways of knowing: new findings on how to improve professional education, *New Directions for Adult and Continuing Education,* Volume 55, pp.109–118

Beer S (1975) *Platforms for change,* Bristol: Wiley (cited in Siemon, 1988)

Begg Andrew J C (ed.) (1993) Assessment in mathematics, in *ICMI(NZ)/6*

Begg, Andrew J C (1991a) *Some Professional Development Models,* paper presented at the 2nd Biennial Conference of the New Zealand Association of Mathematics Teachers, Wellington

Begg, Andrew J C (1991b) *Professional Development of High School Mathematics Teachers: Research Report #1* (A Report to the Research and Statistics Division of the Ministry of Education), Hamilton: Centre for Science and Mathematics Education, University of Waikato

Begg, Andrew J C (1990) MATHSTRENDS: Developments in New Zealand High School Mathematics Education, in: Milton, Ken and McCann, Hugo (eds.) (1990) *Mathematical Turning Points: Strategies for the 1990s* (a collection of papers presented to the 13th Biennial Conference of the Australian Association of Mathematics Teachers), Hobart: Australian Association of Mathematics Teachers, pp.1–14

Bell, Beverley F (ed.) (1993a) *I know about LISP but how do I put it into practice?* Hamilton: University of Waikato, Centre for Science and Mathematics Education Research (Final report of the Learning in Science Project (Teacher Development) for the Ministry of Education)

Bell, Beverley F (1993b) Using anecdotes, in Bell, Beverley F (ed.) (1993a) *I know about LISP but how do I put it into practice?* Hamilton: University of Waikato, Centre for Science and Mathematics Education Research, pp.279–319

Bell, Beverley F and Gilbert, John (1993) Towards a model of teacher development, in: Bell, Beverley F (ed.) (1993a) *I know about LISP but how do I put it into practice?* Hamilton: University of Waikato, Centre for Science and Mathematics Education Research, pp.365–381

Bell, Beverley F and Pearson, John D (1993a) The change process, in Bell, Beverley F (ed.) (1993a) *I know about LISP but how do I put it into practice?* Hamilton: University of Waikato, Centre for Science and Mathematics Education Research, pp.162–183

Bell, Beverley F and Pearson, John D (1993b) Support, in Bell, Beverley F (ed.) (1993a) *I know about LISP but how do I put it into practice?* Hamilton: University of Waikato, Centre for Science and Mathematics Education Research, pp.184–199

Bell, Beverley F and Pearson, John D (1992) Better Learning, *International Journal of Science Education.* 14(3) pp.349–361

Bell, Beverley F; Pearson, John D and Kirkwood, Valda M (1991) *Course components 1990,* Working paper 408, Learning in Science Project (Teacher Development), Hamilton: University of Waikato, Centre for Science and Mathematics Education Research

Bell, Beverley F; Pearson, John D and Kirkwood, Valda M (1990) *Teacher Development, Changing Roles and Learning in Science,* paper prepared as part of the Learning in Science Project (Teacher Development), and presented to the conference of the New Zealand Association for Research in Education, 1990, Auckland

Bell, Beverley F; Osborne, Roger and Tasker, Ross (1985) Finding out what children think, Appendix A of Osborne, Roger and Freyberg, Peter (1985) *Learning in Science: the implications of children's science.* Auckland: Heinemann, pp.151–165

Bell, Les and Day, Christopher (eds.) (1991) *Managing the professional development of teachers.* Buckingham: Open University Press

Bennett deMarrals, Kathleen P (1991) John's Story: An Exploration into Critical Theory in Education, *Adult Learning*, 2(8) pp.9–10 & 17

Berman P and McLaughlin M W (1978) *Federal programs supporting educational change.* Volume VIII: *Implementing and sustaining innovations.* Santa Monica, CA: Rand Corporation (cited in Guskey, 1986, p.6)

Berman P and McLaughlin M W (1977) *Federal programs supporting educational change.* Volume VII: *Factors affecting implementation and continuation,* Santa Monica, CA: Rand Corporation (cited in Fullan and Stiegelbauer p. 71)

Biddulph, Fred; Bell, Beverley and Carr, Margaret (1989) *Constructivist Assessment* Unpublished Paper, Hamilton: University of Waikato, Centre for Science and Mathematics Education Research

Biddulph, Fred and Osborne, Roger (1984) *Making Sense of Our World: an interactive teaching approach,* Hamilton: University of Waikato, Centre for Science and Mathematics Education Research

Blackman, Charles A (1988) Issues in Professional Development: the Continuing Agenda, in: Holly, Mary Louise Hulbert and Mcloughlin, Caven S (1988a) (eds.) *Perspectives on Teacher Professional Development.* New York: The Falmer Press, pp.1–15

Blake, David and Jacques, Kate (1990) Staff Appraisal In Teacher Education, *Educational Management and Administration*, 18(3) pp.32–38

Bocchino, Rob (1993) Are You Planning the Future or Fixing the Past, *Journal of Staff Development,* 14(1) pp.48–52

Bolam, Raymond (1987) What is Effective INSET? in *Professional Development and INSET: Proceedings of the 1987 NFER Members Conference,* England: National Foundation for Educational Research, pp.38–53

Bolam, Raymond (1978) *Innovations in In-Service Education and Training of Teachers, Practice and Theory.* Paris: Organisation for Economic Cooperation and Development (cited in Wallin, 1983)

Borg, Walter R and Gall, Meredith D (1989) *Educational Research: An Introduction* (Fifth Edition). White Plains NY: Longman Inc.

Bradley, Howard (1991) *Staff Development.* London, New York: The Falmer Press

Brandt, Ronald S (1989) On Teacher Empowerment: A Conversation with Ann Lieberman, *Educational Leadership,* 46(8) pp.22–26

Bridges, David (1993) School-based teacher education, in: Bridges, David and Kerry, Trevor (eds.) (1993) *Developing Teachers Professionally: Reflections for Initial and In-service Trainers.* London: Routledge, pp.51–66

Bridges, David and Kerry, Trevor (eds.) (1993) *Developing Teachers Professionally: Reflections for Initial and In-service Trainers.* London: Routledge

Buerk D (1985) The Voices of Women Making Meaning in Mathematics, *Journal of Education* (Boston University), 167(3) pp.59-70 (cited in Anderson, 1989)

Burns, Robert B (1989) The self-concept in teacher education. *The South Pacific Journal of Teacher Education,* 17(2), pp.27–38

Burton, Leone (1987) Women and Mathematics: Is There an Intersection? *IOWME Newsletter*, 3(1) pp.4–7 (cited in Anderson, 1989)

Candy, Philip C (1991) *Self-direction for Lifelong Learning: A comprehensive guide to theory and practice.* San Francisco: Jossey-Bass Inc

Capper, Phillip (1992) Developing Teachers for the Curriculum of the Future. Notes taken from presentation at the seminar *Imperatives for Teacher Development,* at the Principals' Centre, Centre for Continuing Education, University of Auckland (9 October 1992)

Carss, Marjorie (ed.) (1986) *Proceedings of the Fifth International Congress on Mathematical Education* (Adelaide, 1984), Boston: Birkhauser

Carter K, Cushing K, Sabers D, Stein P and Berliner D (1988). Expert-novice differences in perceiving and processing visual classroom information, *Journal of Teacher Education*, 38, pp.25–31 (cited in Richardson, 1990)

Cervero, Ronald M (1992) Professional practice, learning, and continuing education: an integrated perspective, *International Journal of Lifelong Education,* 11(2) pp.91–101

Clark, M Carolyn and Wilson, Arthur L (1991) Context and Rationality in Mezirow's Theory of Transformational Learning, *Adult Education Quarterly,* 41(2) pp.75–91

Clarke, Christopher M (1992) Teachers as Designers in Self-directed professional Development, in: Hargreaves, Andy and Fullan, Michael G (1992) *Understanding Teacher Development.* London/New York: Cassell/Teachers College Press, pp.75–84

Clarke, Douglas M (1991) *The role of staff development programs in facilitating professional growth.* Unpublished manuscript, University of Wisconsin – Madison

Claxton, Guy (1989) *Being a teacher: a positive approach to change and stress,* London: Cassell Educational Ltd

Claxton, Guy and Carr, Malcolm (1991) Understanding Change: The Personal Perspective, *SAMEpapers 1991, pp.*1–14

Cooke, Philip N (1990) *Back to the future: Modernity, postmodernity and locality.* London: Unwin Hyman

Croft, Suzy and Beresford, Peter (1992) The politics of participation, *Critical Social Policy*, 12(2) Issue 35, pp.20–44

Dalin, Åke (1987) *Kompetanseutvikling i arbeidslivet.* Oslo: Cappelen (cited in Dalin, Rolff and Kleekamp, 1993)

Dalin, Per (1986) From leadership training to educational development: IMTEC as an international experience, in: Hoyle, Eric and McMahon, Agnes (eds.) (1986) *The Management of Schools* (World Yearbook of Education) London: Kogan Paul, pp.297–309 (IMTEC is the International Movement Towards Educational Change)

Dalin, Per (1978) *Limits to Educational Change.* London: The Macmillan Press Ltd (in association with The International Movement Towards Educational Change)

D'Ambrosio, Ubiratan (1984) Socio-cultural bases for mathematics education, in Carss M (ed.) (1986) *Proceedings of ICME 5* (Adelaide, 1984) Boston: Birkhauser, pp.1–6.

Daresh, John C (1989) *Supervision as a Proactive Process.* New York: Longman

Davis, Gary; Jones, Arthur and Pearn, Cath (1993) *A Constructivist Approach to Teaching Chaos,* Mathematics Education Research Paper, La Trobe University, Melbourne

Davis, Robert B; Maher, Carolyn A and Noddings, Nel (eds.) (1990) *Constructivist Views on the Teaching and Learning of Mathematics.* Reston: National Council of Teachers of Mathematics

Day, Christopher (1993) The development of teachers' thinking and practice: does choice lead to empowerment? in: Elliott, John (1993) *Reconstructing Teacher Education: Teacher Development.* London: The Falmer Press, pp.125–144

Day, Christopher (1991) Promoting teachers' professional development: a pilot project for primary schools, in: Bell, Les and Day, Christopher (eds.) (1991) *Managing the professional development of teachers.* Buckingham: Open University Press, pp.137–163

Day, Christopher (1988) The Relevance and Use of Classroom Research Literature to the Appraisal of Teachers in Classrooms: issues of teacher learning and change, *Cambridge Journal of Education,* 18(3) pp.333–346

Day, Christopher (1987) Professional Learning through Collaborative In-Service Activity, in: Smyth, John (ed.) (1987a) *Educating Teachers: Changing the nature of pedagogical knowledge.* Lewes, East Sussex: The Falmer Press, pp.207–222

Dean, Joan (1991) *Professional Development in School.* Milton Keynes: Open University Press

Deming, W Edwards (1986) *Out of the crisis.* Cambridge, Massachusetts: Massachusetts Institute of Technology

Department of Education (1989a) *Draft Syllabus Mathematics: Forms 5 to 7.* Wellington: Department of Education

Department of Education (1989b) *Assessment for Better Learning* (A Public Discussion Paper). Wellington: Department of Education

Department of Education (1989c) *Countering Sexism in Education.* Wellington: Department of Education

Department of Education (1989d) *Getting Started on Consultation.* Wellington: Department of Education

Department of Education (1989e) *Charter Framework,* Wellington: Department of Education

Department of Education (1988a) *Assessment Ideas in Mathematics* (Mathematics, Forms 3 to 7, Teachers Guide). Wellington: Department of Education

Department of Education (1988b) *Mathematics with Statistics: Supplement* (Mathematics, Form 7, Teachers Guide). Wellington: Department of Education

Department of Education (1988c) *Administering for Excellence,* (Report of the Taskforce to Review Education Administration). Wellington: Department of Education (Picot Review)

Department of Education (1988d) *Tomorrow's Schools* (The Reform of Education Administration in New Zealand). Wellington: Department of Education

Department of Education (1988e) *National Curriculum Statement* (Draft). Wellington: Department of Education

Department of Education (1988f) *A Staff Development Kit to Support the Draft National Curriculum Statement.* Wellington: Department of Education

Department of Education (1987a) *Mathematics: Forms 1 to 4, Syllabus for Schools.* Wellington: Department of Education

Department of Education (1987b) *The Curriculum Review* (Report of the Committee to Review the Curriculum for Schools). Wellington: Department of Education

Department of Education (1987c) *Mathematics Achievement in New Zealand Secondary Schools* (A Report on the Conduct in New Zealand of the Second International Mathematics Study within the International Association for the Evaluation of Educational Achievement). Wellington: Department of Education

Department of Education (1986a) *Introduction* (Mathematics, Forms 1 to 4, Teachers Guide). Wellington: Department of Education

Department of Education (1986b) *Ideas* (Mathematics, Forms 3 and 4, Teachers Guide). Wellington: Department of Education

Department of Education (1986c) *Mathematics with Statistics* (Mathematics, Form 7, Teachers Guide). Wellington: Department of Education

Department of Education (1986d) *Mathematics with Calculus* (Mathematics, Form 7, Teachers Guide). Wellington: Department of Education

Department of Education (1986e) *Mathematics Discussion Starters* (Draft Edition), Wellington: Department of Education

Department of Education (1986f) *But will it get me a job?* (A Leaver's Profile Resource Booklet). Wellington: Department of Education

Department of Education (1986g) *Learning and Achieving* (Second Report of the Committee of Inquiry into Curriculum, Assessment, and Qualifications in Forms 5 to 7). Wellington: Department of Education

Department of Education (1985a) *Mathematics: Junior Classes to Standard Four, Syllabus for Schools.* Wellington: Department of Education

Department of Education (1985b) *University Entrance Mathematics* (Form 6, Guide Notes for Teachers). Wellington: Department of Education

Department of Education (1984a) *The HOD Manual* (Draft Edition). Auckland: Department of Education (Northern Regional Office)

Department of Education (1984b) *A Review of the Core Curriculum for Schools.* Wellington: Department of Education

Department of Education (1984c) *Analysis of Submissions on the Report A Review of the Core Curriculum for Schools.* Wellington: Department of Education

Department of Education (1983a) *School Certificate Mathematics* (Form 5, Guide Notes for Teachers). Wellington: Department of Education

Department of Education (1983b) *Report of the Secondary School Staffing Working Party.* Wellington: Department of Education

Department of Education (1982) *Teacher Career and Promotion Study.* Wellington: Department of Education

Department of Education (1981) *State Secondary Schools in New Zealand: A Baseline Survey.* Wellington: Department of Education

Department of Education (1979) *Review of Teacher Training.* Wellington: Department of Education

Department of Education (1978) *Report of the Committee on the Registration and Discipline of Teachers.* Wellington: Department of Education

Department of Education (1976) *Towards Partnership* (Report of the Committee on Secondary Education). Wellington: Department of Education

Department of Education (1972) *Mathematics: Forms 1 to 4, Syllabus for Schools.* Wellington: Department of Education

Department of Education and Science (1990) *Developing School Management, The Way Forward* (A Report by the School Management Task Force). London: Her Majesty's Stationery Office

Department of Education and Science (1989) *School Teacher Appraisal: A National Framework* (Report of the National Steering Group on the School Teacher Appraisal Pilot Study). London: Her Majesty's Stationery Office

Department of Education and Science (1987) Curriculum Matters 3, An HMI Series *Mathematics from 5 to 16* (Second edition, incorporating responses). London: Her Majesty's Stationery Office

Department of Education and Science (1985) An HMI Study *Quality in Schools: Evaluation and Appraisal.* London: Her Majesty's Stationery Office

Department of Education and Science (1972) *Teacher education and training* (The James Report). London: Her Majesty's Stationery Office

Department of Education and Science and the Welsh Office (1989) *Mathematics in the National Curriculum.* London: Her Majesty's Stationery Office

Department of Education and Science and the Welsh Office (1988) *Mathematics for ages 5 to 16.* London: Her Majesty's Stationery Office

Department of Education and Science and the Welsh Office (1982) *Mathematics counts* (Report of the Committee of Inquiry into the Teaching of Mathematics in Schools under the Chairmanship of Dr W H Cockcroft). London: Her Majesty's Stationery Office

Derrington, M L (1989) *The Role of the Principal: Tradition, Transition, and Transformation,* Ed D dissertation: University of Washington (cited in Lieberman and Miller, 1990)

Dewey, John (1916) *Democracy and education: an introduction to the philosophy of education.* New York: Macmillan

Diamond, C T Patrick (1991) *Teacher education as transformation: A psychological perspective.* Milton Keynes: Open University Press

Douglas, Bruce (1991) 'Teachers as experts': a case study of school-based staff development, in: Bell, Les and Day, Christopher (eds.) (1991) *Managing the Professional Development of Teachers.* Buckingham: Open University Press, pp.88–109

Doyle, Walter and Ponder, Gerald A (1977). The practicality ethic in teacher decision making, *Interchange*, 8(3) pp.1–12

Drucker, Peter F (1990) *Managing the non-profit organization.* New York: Harper Collins

Dumser, Patricia Mahoney (1991) Mini-Sabbaticals Widen a Teacher's World, *Educational Leadership,* 49(3) pp.77–78

Education and Science Select Committee(1986) *Report on the Inquiry into the Quality of Teaching.* Wellington: Government Printer

Education Review Office (1990) *National Special Review Teacher and ECE Personnel Development.* Wellington: Education Review Office

Edwards, Wayne (1992) Appraising teachers: is there light without heat, *Set* No 1, 1992, Item 2

Elbaz, Freema (1987) Teachers' Knowledge of Teaching: Strategies for Reflection, in: Smyth, John (ed.) (1987a) *Educating Teachers: Changing the nature of pedagogical knowledge.* Lewes, East Sussex: The Falmer Press, pp.45–53

Ellerton, Nerida F and Clements, M A (Ken) (eds.) (1989) *School Mathematics: The Challenge to Change.* Geelong: Deakin University Press

Elliott, John (1993) *Reconstructing Teacher Education: Teacher Development.* London: The Falmer Press

Elliott, John (1989) Educational Theory and the Professional Learning of Teachers: an overview, *Cambridge Journal of Education,* 19(1) pp.81–101

Elliott John (1977) Developing hypotheses about classrooms from teachers' practical constructs: An account of the work of the Ford Teaching Project, in *Interchange*, 7(2) pp.2-22. (cited in Nias, 1987, p141)

Eraut, Michael R (1977) Some perspectives in consultancy in in-service education, *British Journal of In-Service Education,* 4(1/2), pp.95–99 (cited in Williams, 1991)

Erickson, Gaalen L and MacKinnon, Allan M (1990) Seeing classrooms in new ways: on becoming a science teacher, a draft chapter for: Schön, Donald A (ed.) *The Reflective Turn: Case Studies of Reflection In and On Practice.* New York: Teachers College Press

Ernest, Paul (1989a) The Knowledge, Beliefs and Attitudes of the Mathematics Teacher: a Model, *Journal of Education for Teaching,* 15(1) pp.13–33

Ernest, Paul (1989b) Head of the Secondary School Mathematics Department: A Demanding Role, *School Organisation,* 9(3) pp.319–337

Farmer, James A (Jr); Buckmaster, Annette and LeGrand, Barbara (1992) Cognitive apprenticeship: implications for continuing professional education, in Baskett, H K Morris and Marsick, Victoria J (eds) (1992) Professionals' ways of knowing: new findings on how to improve professional education, *New Directions for Adult and Continuing Education,* Volume 55, pp.41–49

Fenstermacher G and Amarel M (1983) The interests of the student, the state, and humanity in education, in: Shulman L and Sykes G (eds.), *Handbook of teaching and policy.* New York: Longman, pp.392–407,(cited in Richardson, 1990)

Flannery, Daniele and Wislock, Robert (1991) Why we do what we do: Our Working Philosophy of Adult Education, *Adult Learning*, 2(8) pp.7–8

Frampton, Ann (1991) *Teacher Development in New Zealand, An examination of current programmes,* a paper presented to the conference of the New Zealand Association for Research in Education, Dunedin

Fullan, Michael G (1993a) Why teachers must become change agents, *Educational Leadership,* 50(6), pp.12–17

Fullan, Michael G (1993b) Innovation, Reform, and Restructuring Strategies, in: Cawelti, Gordon (ed) (1993) *Challenges and Achievements of American Education* (1993 Yearbook of the Association for Supervision and Curriculum Development) Alexandria VA: Association for Supervision and Curriculum Development, pp.116–133

Fullan, Michael G (1989a) Managing Curriculum Change, in: Preedy, Margaret (ed.) (1989) *Approaches to Curriculum Management.* Oxford University Press, pp.144–149

Fullan, Michael G (1989b) Planning, Doing, and Coping with Change, in: Moon, Bob; Murphy, Patricia and Raynor, John (1989) (eds.) *Policies for the Curriculum.* London: Hodder and Stoughton, pp.183–211

Fullan, Michael G (1988a) Performance Appraisal and Curriculum Implementation Research in: Hickcox, Edwards S; Lawton, Stephen B; Leithwood, Kenneth A and Musella, Donald F (eds.) *Making a Difference through Performance Appraisal.* Canada: Ontario Institute for Studies in Education Press, pp.71–83

Fullan, Michael G (1988b) Research into educational innovation, in: Glatter, Ron; Preedy, Margaret; Riches, Colin and Masterton, Mary; (eds.) (1988) *Understanding School Management.* Milton Keynes: Open University Press, pp.195–211

Fullan, Michael G (1986) The management of change, in: Hoyle, Eric and McMahon, Agnes (eds.) (1986) *The Management of Schools* (World Yearbook of Education). London: Kogan Paul, pp.73–86

Fullan, Michael G (1985a) Change process and strategies at the local level, *Elementary School Journal,* 85(3), pp.391–421

Fullan, Michael G (1985b) Integrating Theory and Practice, in: Hopkins, David and Reid, Ken (eds.) (1985) *Rethinking Teacher Education.* Beckenham, Croom Helm, pp.195–211

Fullan, Michael G (1982a) *The Meaning of Educational Change.* New York: Teachers College Press

Fullan, Michael G (1982b) Research into educational innovation, in Gray H L (ed.) (1982) *The Management of Educational Institutions Theory Research and Consultancy.* The Falmer Press, pp.245–261

Fullan, Michael G; Bennett, Barrie and Rolheiser-Bennett, Carol (1990) Linking Classroom and School Improvement, *Educational Leadership,* 47(8) pp.13–19

Fullan, Michael G and Hargreaves, Andy (eds.) (1992) *Teacher Development and Educational Change.* London, New York: The Falmer Press

Fullan, Michael G and Miles, Matthew B (1992) Getting Reform Right: What Works and What Doesn't, *Phi Delta Kappan,* June 1992, pp.745–752

Fullan, Michael G. with Stiegelbauer, Suzanne (1991) *The New Meaning of Educational Change.* New York: Teachers College Press, (Second edition, first published as Fullan (1982) *The Meaning of Educational Change*).

Gardner, Howard (1991) *The unschooled mind: how children think and how teachers should teach.* New York: Basic Books

Gibbons, Maurice and Norman, Peter (1987) An Integrated Model for Sustained Staff Development, in: Wideen, Marvin F and Andrews, Ian (eds.) (1987) *Staff Development for School Improvement: a focus on the teacher.* New York: The Falmer Press, pp.103–110

Gilbert, Jane (1993) A Review of the Literature, in: Bell, Beverley F (ed.) (1993a) *I know about LISP but how do I put it into practice?* Hamilton: University of Waikato, Centre for Science and Mathematics Education Research, pp.15–38

Gillespie, June (1990) *Starter Kit for the Induction of New Teachers* (Updated edition). Dunedin: Dunedin College of Education, Secondary Schools Advisory Services

Gillespie, June & Spencer, Neil (1990) *The HOD Manual: A guide to middle management.* (Revised edition) Dunedin: Dunedin College of Education, Secondary Schools Advisory Services

Gilligan, Carol (1982) *In A Different Voice*. Cambridge, MA: Harvard University Press (cited in Anderson, 1989)

Giroux, Henry A (1990) *Curriculum Discourse as Postmodernist Critical Practice.* Geelong: Deakin University Press

Glatter, Ron: Preedy, Margaret; Riches, Colin and Masterton, Mary (1988) (eds.) *Understanding School Management.* Milton Keynes: Open University Press

Goldenberg, Claude and Gallimore, Ronald (1991) Changing Teaching Takes More Than a One-Shot Workshop, *Educational Leadership,* 49(3) pp.69–72

Guba, Egon G (1990a) (ed.) *The Paradigm Dialog.* Newbury Park, CA: Sage Publications

Guba, Egon G (1990b) The Alternative Paradigm Dialog, in: Guba, Egon G (1990a) (ed.) *The Paradigm Dialog.* Newbury Park, CA: Sage Publications, pp.17–27

Guba, Egon G & Lincoln, Yvonna S (1989) *Fourth generation evaluation.* Newbury Park, CA: Sage Publications (cited in Maxwell, 1992)

Guba, Egon G and Lincoln, Yvonna S (1981) *Effective Evaluation.* San Francisco: Jossey-Bass

Guskey, Thomas R (1988) Teacher efficacy, self concept and attitudes towards the implementation of instructional innovation, *Teaching and Teacher Education,* 4, pp.63–69

Guskey, Thomas R (1986) Staff Development and the Process of Teacher Change, *Educational Researcher,* 15(5) pp.5–12

Guskey, Thomas R and Sparks, Dennis (1991) What to Consider when Evaluating Staff Development, *Educational Leadership,* 49(3) pp.73–76

Hamachek, Don E (1987) *Encounters with the self* (3rd edition). New York: Holt, Rinehart, and Winston (cited in McCarty, 1993)

Handel G (1990) Promoting the articulation of tacit knowledge through the counselling of practitioners, Keynote address at APC Conference, Amsterdam, 6–8 April 1990 (cited in Day, 1993)

Hannay, Lynne M & Denby, Mae (1993) *The Role of Secondary Department Heads in Facilitating Change,* paper presented at the 21st Annual Conference of the Canadian Society for the Study of Education, Ottawa, June 1993

Hargreaves, Andy (1994b) Restructuring restructuring: postmodernity and the prospects for educational change. Journal of Education Policy, 9(1), pp.47–65

Hargreaves, Andy and Fullan, Michael G (1992) *Understanding Teacher Development.* London/New York: Cassell/Teachers College Press

Hewton, Eric (1988) *School Focused Staff Development.* London, New York: The Falmer Press

Hickcox, Edwards S; Lawton, Stephen B; Leithwood, Kenneth A; and Musella, Donald F, (eds.) *Making a Difference through Performance Appraisal.* Toronto: Ontario Institute for Studies in Education Press

Hollingsworth, Sandra (1992) Learning to Teach Through Collaborative Conversation: A Feminist Approach, *American Educational Research Journal,* 29(2) pp.373–404

Holly, Mary Louise Hulbert and Mcloughlin, Caven S (1988a) (eds.) *Perspectives on Teacher Professional Development.* New York: The Falmer Press

Holly, Mary Louise Hulbert and Mcloughlin, Caven S (1988b) Professional Development and Journal Writing, in: Holly, Mary Louise Hulbert and Mcloughlin, Caven S (1988a) (eds.) *Perspectives on Teacher Professional Development.* New York: The Falmer Press, pp.259–283

Holt, Maurice (1993) The Educational Consequences of W Edwards Deming, in *Phi Delta Kappan* 74(5) pp.382–388

Hoyle, Eric and Megarry, Jacquetta (eds.) (1980) *Professional Development of Teachers* (World Yearbook of Education). London: Kogan Paul

Huberman, Michael (1989) The Professional Life Cycle of Teachers, *Teachers College Record,* 91(1) pp.31–57

Huberman, Michael and Miles, Matthew B (1984) *Innovation up close: How school improvement works.* New York: Plenum

Hudson, Frederick M (1991) *The Adult Years: Mastering the Art of Self-Renewal.* San Francisco: Jossey-Bass Inc.

Jackson, Philip E W (1992) Helping Teachers Develop, in: Hargreaves, Andy and Fullan, Michael G (1992) *Understanding Teacher Development.* London/New York: Cassell/Teachers College Press, pp.62–74

Jaworski, Barbara (1991) Develop Your Teaching, *Mathematics in School,* 20(1) pp.17–21

Jaworski, Barbara (1988) "Is" versus "seeing as": constructivism and the mathematics classroom, in: Pimm David (ed.) (1988) *Mathematics, teachers and children.* London: Hodder and Stoughton, pp.288–292

Jaworski, Barbara (chair); Duffin, Janet; Garrard, Wendy; James, Nick; Marland, Harriet; Tyson, Anne; Wooldridge, David and Young, Rod (1991) *Develop Your Teaching.* England: The Mathematical Association and Stanley Thornes Ltd (Produced by the Teacher-centred Inservice in Mathematics Education Subcommittee)

Joffe, Lynn and Foxman, Derek (1989) *Communicating Mathematical Ideas: A practical interactive approach at ages 11 and 15.* London: Her Majesty's Stationery Office (for Assessment of Performance Unit)

Joyce, Bruce R and Showers, Beverly (1982) The coaching of teaching, *Educational Leadership,* 40(1), pp.4–10

Joyce, Bruce R and Showers, Beverly (1980) Improving inservice training: The messages of research, *Educational Leadership,* 37(5) pp.379–385

Judson, Arnold S. (1991) *Changing Behaviour in Organisations: Minimising Resistance to Change.* Cambridge MA: Basil Blackwell, (revised edition of Judson A S (1966) *A manager's guide to making changes*)

Kelchtermans, Geert and Vandenberghe, Roland (1994) Teachers' professional development: a biographical perspective. *Journal of Curriculum Studies* 26(1), pp.45–62

Kennedy, Mary M (1991) Some Surprising Findings on How Teachers Learn to Teach, *Educational Leadership,* 49(3) pp.14–17

Killion, Joellen P (1993) Staff Development and Curriculum Development: Two Sides of the Same Coin, *Journal of Staff Development,* 14(1) pp.38–41

Kincheloe, Joe L (1991) *Teachers as researchers: qualitative inquiry as a path to empowerment,* London, Philadelphia: The Falmer Press

Knott, Christine and Wendy Cole (1989) Conferences: A Search for Quality, *Adults Learning*, 1(2) pp.49–51

Knowles, Michael C (1990) *Organisational Behaviour: Changing Concepts and Applications.* Sydney: Harper and Row (Australasia) Pty Limited

Krupp, Judy-Arin (1987) Understanding and Motivating Personnel in the Second Half of Life, *Journal of Education* (Boston University), 169(1) pp.20–46

Lather, Patti (1991) *Getting Smart.* New York: Routledge

Leinwand, Steven J (1992) Sharing, Supporting, Risk Taking: First Steps to Instructional Reform, *The Mathematics Teacher,* 85(6) pp.466–470

Levine, Sarah L (1987) Peer support for women in middle management, *Educational Leadership* 45(3) pp.74–75

Lieberman, Ann and Miller, Lynne (1990) Teacher Development in Professional Practice Schools, *Teachers College Record,* 92(1) pp.107–122

Lieberman, Ann and Miller, Lynne (1981) Supporting Classroom Change, in: Price, Jack and Gawronski, J D (eds.) (1981) *Changing School Mathematics: A Responsive Process.* Reston, National Council of Teachers of Mathematics, pp.52–64

Lincoln, Yvonna S (1990) The Making of a Constructivist, A Remembrance of Transformations Past, in: Guba, Egon G (1990) (ed.) *The Paradigm Dialog.* Newbury Park, CA: Sage Publications, pp.67–87

Lincoln, Yvonna S and Guba, Egon G (1985) *Naturalistic Inquiry.* Beverly Hills: Sage Publications

Little, Judith Warren (1992) Teacher Development and Educational Policy, in: Fullan, Michael G and Hargreaves, Andy (eds.) (1992) *Teacher Development and Educational Change.* London, New York: The Falmer Press, pp.170–193

Logan, Lloyd and Sachs, Judyth (1991) Which Teacher Development Project? *School Organisation,* 11(3) pp.303–311

Lortie, Dan C (1975) *Schoolteacher: A sociological study.* Chicago: University of Chicago Press

Loucks-Horsley, S and Hergert, L F (1985) *An Action Guide to School Improvement, Andover.* Massachusetts: Association for Supervision and Curriculum Development, The Network: Andover, MA (cited in Fullan, 1986)

Louis, Karen Seashore and Miles, Matthew B (1990) *Improving the urban high school: what works and why.* New York: Teachers College Press.

Lowe, John (1989) *Schools and Quality: An International Report.* Paris: Organisation for Economic Cooperation and Development

Marland M and Hill, S (ed.) (1981) *Departmental Management.* London: Heinemann (cited in Ribbins, 1988)

Marris, Peter (1974) *Loss and change.* New York: Anchor Press/Doubleday

Marshall, Catherine (1990) Goodness Criteria: Are They Objective or Judgement Calls? in: Guba, Egon G (1990) (ed.) *The Paradigm Dialog.* Newbury Park, CA: Sage Publications, pp.188–197

Mathias, John R and Jones, Jeff L (1989) *Appraisal of performance: an aid to professional development Teachers' guide.* Windsor: NFER-NELSON Publishing Co Ltd

Mathnews (1985-89) Numbers 11–22, Wellington: Department of Education (Begg, Andrew J C, ed.)

Mathsplus (1991-92) Numbers 1–4, Hamilton: University of Waikato, Centre for Science and Mathematics Education Research, for Ministry of Education (Begg, Andrew J C, ed.)

Maxwell, Joseph A (1992) Understanding and Validity in Qualitative Research, *Harvard Educational Review,* 62(3) pp.279–300

McCarty, Hanoch (1993) From Deadwood to Greenwood: Working with Burned Out Staff, *Journal of Staff Development,* 14(1) pp.42–46

McKeon, Richard (1952) Philosophy and Action, *Ethics,* volume 62, pp.79–100 (cited in Holt, 1993a)

McKibbin, Michael and Joyce, Bruce (1980) Psychological states and staff development, *Theory Into Practice* 19(4) pp.325–340 (cited in Showers, Joyce and Bennett, 1987)

McLaughlin, Milbrey Wallin (1991) Enabling professional development: What have we learned? In: Lieberman, Ann and Miller, Lynne (eds.) (1991) *Staff Development for Education in the 90s.* New York: Teachers College Press, pp.61–82 (cited in Clarke, 1991)

McLaughlin, Milbrey Wallin (1990) *Enabling Professional Development: What Have We Learned?* Working Paper #90-114, Center for Research on the Context of Secondary Teaching, Stanford University (draft of a chapter for Lieberman and Miller (eds.) (1991) *Staff Development for Education in the 90s.* New York: Teachers College Press)

McLaughlin, Milbrey Wallin and Marsh, D D (1978) Staff development and school change, *Teachers College Record* 80, pp.69–94 (cited in Clarke, 1991)

McLaughlin, Milbrey Wallin and Pfeifer, R Scott (1988) Teacher Evaluation: Organizational Change, Accountability, and Improvement in: Hickcox, Edwards S; Lawton, Stephen B; Leithwood, Kenneth A and Musella, Donald F (eds.) *Making a Difference through Performance Appraisal.* Toronto: Ontario Institute for Studies in Education Press, pp.113–140

McMahon, Agnes (1981) The Role of the School-based Tutor in the Professional Development of Teachers, *Journal of Education* (Boston University), 163(2) pp.184–199

McMullen, Helen (1991) The role of appraisal in staff development, in: Bell, Les and Day, Christopher (eds.) (1991) *Managing the professional development of teachers.* Buckingham: Open University Press, pp.164–175

Meeder, Marja (1992) *Personal communication* during a working group discussion at ICME 7 in Quebec.

Mellin-Olsen, Steig (1993) *A critical view of assessment in mathematics education: where is the student as a subject?* in Niss, Mogens (ed) (1993) Investigation into Assessment in Mathematics Education, An ICMI Study, Dordrecht, The Netherlands: Kluwer, pp.143–156 (Paper presented at ICMI Study Conference on Assessment in Mathematics Education and Its Effects: Calonge, Spain, April 1991)

Mercer, David and Evans, Barbara (1991) Professional Myopia: job satisfaction and the management of teachers, *School Organisation,* 11(3) pp.291–301

Merriam, Sharan B (1988) *Case Study Research in Education: a qualitative approach.* San Francisco: Jossey Bass Publishers

Merriam, Sharan B and Simpson, Edwin L (1989) *A Guide to Research for Educators and Trainers of Adults* (Updated Edition). Malabar Florida; Robert E Krieger Publishing Company Inc

Mezirow, Jack (1990). *Fostering critical reflection in adulthood: A guide to transformative and emancipatory learning.* San Francisco: Jossey-Bass (cited in Clark and Wilson, 1991)

Ministry of Education (1993)*The New Zealand Curriculum Framework.* Wellington: Ministry of Education, Learning Media

Ministry of Education (1992a) *Mathematics in the National Curriculum (Draft).* Wellington: Ministry of Education, Learning Media

Ministry of Education (1992b) *Mathematics in the New Zealand Curriculum.* Wellington: Ministry of Education, Learning Media

Ministry of Education (1991) Teacher Development, *The New Zealand Education Gazette*, 70(10) pp.1–2

Ministry of Education (1990a) *Guidelines for Success in Consultation.* Wellington: Ministry of Education, Learning Media

Ministry of Education (1990b) *Tomorrow's Standards.* Wellington: Ministry of Education, Learning Media

Ministry of Education (1990c) (Noel V Lough, Chairperson) *Today's Schools.* Wellington: Ministry of Education

Ministry of Education (1990d) (Jack Shallcrass, Chairperson) *School Development: Review of Advisory Services.* Wellington: Ministry of Education

Ministry of Education (1990e) National Education Guidelines, *A Supplement to the Education Gazette*, 69(2) pp.1–4

Mortimore, Peter and Mortimore, Jo (1991) Teacher Appraisal: back to the future in *School Organisation,* 11(2) pp.125–143

Mousley, Judith A and Rice, Mary (1989) Teaching and Researching Mathematics Education Off-Campus: Pedagogical Evaluation and Change, in: Evans, Terry D (ed.) (1989) *Research in Distance Education.* Geelong: Deakin University Press, pp.180–195

Naisbitt, John (1982) *Megatrends.* New York: Warner Books

National Council of Teachers of Mathematics (1991) *Professional Standards for School Mathematics.* Reston: National Council of Teachers of Mathematics

National Council of Teachers of Mathematics (1989) *Curriculum and Evaluation Standards for School Mathematics.* Reston: National Council of Teachers of Mathematics

National Council of Teachers of Mathematics (1980) *An Agenda for Action.* Reston: National Council of Teachers of Mathematics

National Educational Service Foundation (1993) NES Foundation Leads Quality Movement in Education. *Quality Learning* 1(1) p1. Winter 1993/94

National Mathematics and Statistics CBL Review Panel (eds.) (1986) *Will Mathematics Count.* England: AUCBE

National Research Council (1990) *Reshaping School Mathematics: A Philosophy and Framework for Curriculum.* Washington: National Academy Press

National Research Council (1989) *Everybody Counts* (A Report to the Nation on the Future of Mathematics Education). Washington: National Academy Press

New Zealand Employers' Federation, (ed) Ross Pedder (1981) *Secondary Education and the Path to Work.* Wellington: New Zealand Employers' Federation

New Zealand EQUALS Network (1989) *Mathematics Teaching: Making Changes.* Glen Waverley, Victoria: Latitude Publications

New Zealand Post Primary Teachers' Association (1991) *Teacher Performance Appraisal,* an Annual Conference paper prepared by the National Executive, Wellington: New Zealand Post Primary Teachers' Association

Nias, Jennifer (1987) Learning From Difference: A Collegial Approach to Change, in: Smyth, John (ed.) (1987a) *Educating Teachers: Changing the nature of pedagogical knowledge.* Lewes, East Sussex: The Falmer Press, pp.137–152

Nias, Jennifer (1986) *Teacher Socialisation: the individual in the system.* Geelong: Deakin University Press

Niss, Mogens (ed) (1993) Investigation into Assessment in Mathematics Education, An ICMI Study, Dordrecht, The Netherlands: Kluwe

Noddings, Nel (1990) Constructivism in Mathematics Education, in: Davis, Robert B; Maher, Carolyn A, and Noddings, Nel (1990) (eds.) *Constructivist Views on the Teaching and Learning of Mathematics.* Reston: National Council for Teachers of Mathematics, pp.7–18

Oberg, Antoinette and Underwood, Susan (1989) Facilitating Teacher Self-development: Reflections on Experience, paper presented at the invitational conference on Teacher Development: Policies, Practices and Research, OISE Toronto, reprinted in: Hargreaves, Andy and Fullan, Michael G. (1992) *Understanding Teacher Development.* London/New York: Cassell/Teachers College Press, pp.162–177

Ohia, Monte; Moloney, Mihi and Knight, Gordon (1990) *Case Studies of Mathematics Education in New Zealand Secondary School Bilingual Units,* Research Report, Palmerston North: Massey University

Ohia, Monte; Moloney, Mihi and Knight, Gordon (1989) *A Survey of Mathematics Teaching in New Zealand Secondary School Bilingual Units,* Research Report, Palmerston North: Massey University

Oja, Sharon Nodie (1988) Teachers: Ages and Stages of Adult Development, in: Holly, Mary Louise Hulbert and Mcloughlin, Caven S (1988a) (eds.) *Perspectives on Teacher Professional Development.* New York: The Falmer Press, pp.119–154

Oja, Sharon Nodie (1983) Life age/cycle characteristics of ARCS teachers, in: Oja, Sharon Nodie and Pine, G J (1983) *A two year study of teacher stages of development in relation to collaborative action research in schools*: appendix to the final report (p. 755). Washington: National Institute of Education (ERIC Document Reproduction Service No. ED 248 227) (cited in Oja, 1988)

Organisation for Economic Co-operation and Development (1990) *The Teacher Today: tasks, conditions, policies.* Paris: Organisation for Economic Co-operation and Development (OECD)

Osborne, Roger and Freyberg, Peter (1985) *Learning in Science: the implications of children's science.* Auckland: Heineman

Owen, John; Johnson, Neville; Clarke, Doug; Lovitt, Charles and Morony, Will (1988) (Mathematics Curriculum and Teaching Program) *Guidelines for Consultants and Curriculum Leaders.* Canberra: Curriculum Development Centre

Pegg, John and Redden, Ted (1991) *Analysis of a Framework for Professional Inservice Development of Secondary Mathematics Teachers in a Rural Environment,* paper presented at the 14th Annual Conference of the Mathematics Education Research Group Australasia, Perth

Perls, Frederick S; Hefferline, Ralph F and Goodman, Paul (1951) *Gestalt therapy: Excitement and Growth in the Human personality.* New York: Julian Press (cited in Robinson, 1989)

Peter, Andrea; Clarke, David; Carlin, Paul and Harmes, Mary (1992) Teachers Adjusting to Change, in: Horne, Marj and Supple, Marjorie (eds) (1992) *Mathematics: Meeting the Challenge* (Proceedings of the 29th annual conference of the Mathematical Association of Victoria). Melbourne: Mathematical Association of Victoria, pp.191–196

Peters, Michael; Marshall, James and Massey, Lauran (1994) Recent educational reforms in Aotearoa, in Coxon E, Jenkins E; Marshall J and Massey L (eds) (1994) *The Politics of Learning and Teaching in Aotearoa-New Zealand.* Palmerston North: The Dunmore Press

Pimm, David (ed.) (1988) *Mathematics, teachers and children.* London: Hodder and Stoughton

Polya, George (1957) *How to solve it: a new aspect of mathematical method.* New York: Doubleday

Posner, George J; Strike, Kenneth A; Hewson, Peter W and Gertzog, William A (1982) Accommodation of a Scientific Conception: Toward a Theory of Conceptual Change, *Science Education,* 66 (2) pp.211–227

Pratt, Daniel D (1988) Andragogy as a relational construct, *Adult Education Quarterly,* 38(3) pp.160–181

Price, Jack and Gawronski J D (1981) *Changing School Mathematics, A Responsive Process.* Reston: National Council of Teachers of Mathematics

Quinn, Michael T (1989) Staff Development: A Process of Growth, *Excellence in Teaching,* 6(4) pp.4–6.

Raymond, Danielle; Butt, Richard and Townsend, David (1992) Contexts for Teacher Development: Insights from Teachers' Stories, in: Hargreaves, Andy and Fullan, Michael G (1992) *Understanding Teacher Development.* London/New York: Cassell/Teachers College Press, pp.143–161

Ribbins, Peter (1988) The role of the middle manager in the secondary school, in: Glatter, Ron: Preedy, Margaret; Riches, Colin and Masterton, Mary (1988) *Understanding School Management.* Milton Keynes: Open University Press, pp.58–77

Rice, Mary (1992) *Towards a Professional Development Ethos,* paper presented at the 15th Annual Conference of the Mathematics Education Research Group of Australasia, University of Western Sydney

Richardson Virginia (1990) Significant and worthwhile change in teaching practice, *Educational Researcher, 19,* pp.10–18

Robertson, Heather-jane (1992) Teacher Development and Gender Equity, in: Hargreaves, Andy and Fullan, Michael G (1992) *Understanding Teacher Development.* London/New York: Cassell/Teachers College Press, pp.43–61

Robinson, Ian (1989) The Empowerment Paradigm for the Professional Development of Teachers of Mathematics, in: Ellerton, Nerida F and Clements, M A (Ken) (eds.) (1989) *School Mathematics: The challenge to change.* Geelong: Deakin University Press, pp.269–283

Rodrigues, Susan (1992) *Preliminary findings on the role of context on students learning redox concepts in the sixth form,* a seminar presented at the University of Waikato, Centre for Science and Mathematics Education Research,

Rodriguez, Carmen D. (1991) Learners Take Action, *Adult Learning,* 2(8) pp.24–28

Rogers, Carl R (1969) *Freedom to Learn.* Columbus, Ohio: Charles E. Merrill Publishing

Rogers, Carl R (1961) *On Becoming a Person.* London: Constable

Rudduck, Jean (1988) The Ownership of Change as a Basis for Teachers' Professional Learning, in: Calderhead, James (ed.) (1988a) *Teachers' Professional Learning.* London, New York: The Falmer Press, pp.205–222

Sadowski, Lynda L (1993) Staff development 101 for administrators: alternatives for thirteen management myths, *Journal of Staff Development,* 14(3) pp.46–50

Schlechty P and Whitford B (1983) The organizational context of school systems and the functions of staff development, in: Griffin G (ed.) *Staff development: Eighty-second yearbook of the National Society for the Study of Education,* Part II, Chicago: University of Chicago Press, pp.62-91 (cited in Smylie, 1988)

Schön, Donald A (1987) *Educating the Reflective Practitioner: Towards a New Design for Teaching and learning in the Professions.* San Francisco: Jossey-Bass

Schön, Donald A (1983) *The Reflective Practitioner: How professionals think in action.* New York: Basic Books Inc

Schrum, Lynne (1991) Teacher Education Goes Online, *Educational Leadership,* 49(3) pp.39–42

Scottish Education Department (1989) *Planned Activities a review of good practice in primary and secondary schools* (A Report by HM Inspectors of Schools). Scotland: Scottish Education Department

Senge, Peter M (1990) *The fifth discipline.* New York: Doubleday/Currency. (cited in Bocchino, 1993)

Siemon, Dianne E (1988) Knowing and believing is seeing: A constructivist's perspective of change, in: Ellerton, Nerida F and Clements, M A (Ken) (eds.) (1989) *School Mathematics: The Challenge to Change.* Geelong: Deakin University Press, pp.250–268 (Presented as a plenary address to the 11th Annual Conference of the Mathematics Education Research Group of Australasia, Deakin University, 1988)

Sikes, Patricia J (1992) Imposed Change and Experienced Teacher, in: Fullan, Michael G and Hargreaves, Andy (eds.) (1992), *Teacher Development and Educational Change.* London, New York: The Falmer Press, pp.36–55

Silvester, Janet K (1989) *Teacher Change: The Literature Review,* Working paper 404 from Learning in Science Project (Teaching), Hamilton: University of Waikato, Centre for Science and Mathematics Education Research

Simon, Martin A and Schifter, Deborah (1991) Towards a Constructivist Perspective: An Intervention Study of Mathematics Teacher Development, *Educational Studies in Mathematics*, 22, pp.309–331

Skemp, Richard R (1989) *Mathematics in the Primary School.* London: Routledge

Skilbeck, Malcolm (1990) *Curriculum Reform, An Overview of Trends.* Paris: Organisation for Economic Co-operation and Development (OECD)

Smith John K (1990) Alternative Research Paradigms and the Problem of Criteria, in: Guba, Egon G (1990) (ed.) *The Paradigm Dialog,* Newbury Park, CA: Sage Publications, pp.167–187

Smylie, Mark A (1988) The Enhancement Function of Staff Development: Organizational and Psychological Antecedents to Individual Teacher Change, *American Educational Research Journal* 25(1), pp.1-30

Smyth, John (1992) Teachers' Work and the Politics of Reflection, *American Educational Research Journal,* 29(2) pp.267–300

Smyth, John (ed.) (1987) *Educating Teachers: Changing the nature of pedagogical knowledge.* Lewes, East Sussex: The Falmer Press

Staessens, Katrine and Vandenberghe, Roland (1994) Vision as a core component in school culture, Journal of Curriculum Studies 26(2), pp.187–200

Stake, Robert E; Shapson, Stanley and Russell, Linda (1987) Evaluation of Staff Development Programs, in: Wideen, Marvin F and Andrews, Ian (ed.) (1987) *Staff Development for School Improvement: a focus on the teacher,* New York: The Falmer Press, pp.196–212

Stewart, David J and Prebble, Tom (1985) *Making it happen: a school development process.* Palmerston North: Dunmore

Support for Innovation Project (1989) *Thinking Schools.* Cambridge, Cambridge Institute of Education (cited in Bradley, 1991)

Tafel, Linda and Bertani, Albert (1992) Reconceptualizing Staff Development for Systemic Change, *Journal of Staff Development,* 13(4) pp.42–45

Taylor, Peter C S (1991) Collaborating to reconstruct teaching: the influence of researcher beliefs, paper presented at the annual meeting of the American Educational Research Association, Chicago, April 1991 (To appear in Tobin K (ed.) (in press) *The practice of constructivism in science and mathematics education.* Washington DC: American Association for the Advancement of Science)

Taylor, Ross (ed.) (1986) *Professional Development for Teachers of Mathematics: A Handbook.* Reston: National Council of Teachers of Mathematics

Taylor, Ross (1981) *Developing Support for Change,* in: Price, Jack and Gawronski, J D (eds.) (1981) *Changing School Mathematics: A Responsive Process.* Reston: National Council of Teachers of Mathematics, pp.128–146

Taylor, William (1980) Professional development or personal development, in: Hoyle, Eric and Megarry, Jacquetta (eds.) (1980) *Professional Development of Teachers* (World Yearbook of Education). London: Kogan Paul, p 327–339.

Thiessen, Dennis (1992) Classroom-based Teacher Development, in: Hargreaves, Andy and Fullan, Michael G (1992) *Understanding Teacher Development.* London/New York: Cassell/Teachers College Press, pp.85–109

Thomas, Norman (1991) Monitoring and evaluating school-centred staff development, in: Bell, Les; Day, Christopher (eds.) (1991) *Managing the Professional Development of Teachers.* Buckingham: Open University Press, pp.125–136

Tripp, David H (1988) On Collaboration: teachers, self-assessment and professional journals, *Cambridge Journal of Education,* 18(3) pp.313–332

von Glasersfeld, Ernst (1991) Knowing without Metaphysics: Aspects of the Radical Constructivist Position, in: Steier, Frederick (1991) *Research and Reflexivity.* London: Sage Publications, pp.12–29

von Glasersfeld, Ernst (1990) An exposition of constructivism: Why some like it radical, in: Davis, Robert B; Maher, Carolyn A and Noddings, Nel (eds.) (1990) *Constructivist Views on the Teaching and Learning of Mathematics.* Reston: National Council of Teachers of Mathematics, pp.19–29.

von Glasersfeld, Ernst (1989) Constructivism in Education, in: *The International Encyclopaedia of Education: Research and Studies.* Supplementary Volume. Oxford (England), New York: Pergamon Press, pp.162–163

Werry, Bevan W (1980) *Mathematics in New Zealand Secondary School.* Wellington: New Zealand Council for Educational Research

Wideen, Marvin F (1987) Perspectives on Staff Development, in: Wideen, Marvin F and Andrews, Ian (ed.) (1987) *Staff Development for School Improvement: a focus on the teacher.* New York: The Falmer Press, pp.1–15

Wideen, Marvin F and Andrews, Ian (ed.) (1987) *Staff Development for School Improvement: a focus on the teacher.* New York: The Falmer Press

Wiersma, William (1986) *Research Methods in Education: An Introduction (Fourth Edition),* Massachusetts: Allyn and Bacon Inc

Wildman, Terry M and Niles, Jerry A (1987) Essentials of Professional Growth, *Education Leadership,* 44(5) pp.4–10

Williams, Michael (1991) *In-Service Education and Training: policies and practice.* London: Cassell Educational Limited

Woods, Peter (1987) Life Histories and Teacher Knowledge, in: Smyth, John (ed.) (1987a) *Educating Teachers: Changing the nature of pedagogical knowledge.* Lewes, East Sussex: The Falmer Press, pp.121–135

Wright, David R (1993) Can 'professional development' de-professionalise the teaching profession? in: Bridges, David and Kerry, Trevor (eds.) (1993) *Developing Teachers Professionally: Reflections for Initial and In-service Trainers.* London: Routledge, pp.123–149