Influences on practice in the mathematics classroom: An investigation into the beliefs and practices of beginning teachers

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ABSTRACT

This study reports on an investigation into some of the issues impacting on the provision of equitable classroom programmes in mathematics by beginning teachers, and focuses in particular, on the ways in which the teachers were able to cater for both the girls and boys in their classes. Due to the constructivist environment within which their pre-service mathematics education courses had been presented, constructivist principles formed the belief-framework for the teachers. The initial aim was to explore the relationship between the beliefs and practices of beginning teachers but during the course of the study, it became apparent that teacher-belief is only one of the many factors influencing practice. Therefore, a case study approach was used, to explore what life is really like, for six teachers in their first year of primary teaching. The findings from the study confirmed the complexity of classroom research and identified, in particular, three crucial issues of influence on practice: the teachers' own beliefs about mathematics and mathematics teaching; the mathematics curriculum and its philosophy; and the process of socialisation into their school culture as it affected their professional survival as teachers. The results of the study have implications for all involved in the support of beginning teachers and in particular, for pre-service educators.

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CHAPTER 1

INTRODUCTION

1.1 RATIONALE

Much of the research on gender-equity within mathematics has been of a quantitative nature with data analysed according to measurable achievements. Research of this kind has focused on the students in the classroom and the achievements of girls are usually compared to those of boys (Shuard, 1983; Fennema & Tartre, 1985; Morton, Pemberton, Reilly, B. J., Reilly, I. L. & Lee, 1988; Young-Loveridge, 1991; Bishop & Clements, 1994; Blithe & Clarke, 1995). This tradition of comparative analysis means that success in mathematics tends to have been measured according to summative outcomes as opposed to focusing on the quality of access and participation within ongoing mathematics classroom programmes.

The provision of any classroom programme depends to a certain extent on the espoused beliefs of the teacher. These beliefs are formed through the interaction of personal and societal factors before embarking on a pre-service teacher education programme and are often adjusted or strengthened during the period of pre-service teacher education. Within the context of mathematics education, research has established that provision for successful mathematics learning in the classroom is dependent on the individual teacher's beliefs and confidence about not only the pedagogical aspects of mathematics but also about mathematics itself (Fennema, 1990a; Fennema & Franke, 1992; Laurenson, 1995; Sullivan & Leder, 1992). Furthermore then, in terms of planning and implementing equitable mathematics programmes, beliefs which are sensitive to gender-equity combine with beliefs on the teaching of mathematics. Yet despite teacher beliefs and intentions, does a rich mathematics learning environment enable

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girls to access learning, to take risks and more importantly, to enjoy their mathematical experiences? Fennema (1990a: 184) writes

> Teachers try to make their classrooms pleasant places to be. In particular, they are concerned that their female students be comfortable and not subjected to much stress. But, in doing so, they fail to permit their female students to develop a real sense of pride in their own ability to do mathematics and to continue to learn mathematics. Females are not permitted to become independent learners of mathematics, do not come to believe that the reason they succeed in mathematics is because of their ability, and do not develop adequate self-esteem in mathematics.... When asked why they spend more time with males than with females, teachers often reply it is because the males demand more time. Sometimes, if attention is not paid to the males, they become unruly and often disrupt the entire classroom. At other times, teachers report that they can depend on a male for a response that will enable the class to move forward ... if teachers' actions totally reflect their beliefs, then they must believe that equity is achieved when all learners have equal access.

Within the current climate of constructivism, teachers' beliefs increasingly appear to recognise and value the place of the learner in the learning process. Hence the rationale for this study was to examine teachers' beliefs about both constructivism and gender, and to explore the development and adjustment of these beliefs as teachers moved from pre-service teacher education into their first year of teaching.

1.2 THE STUDY

With the intention of examining what it is really like for girls in a co-educational mathematics classroom in a New Zealand primary school, the study explored the classroom environment from the teacher's perspective: investigating how first year teachers were able to provide gender-equitable programmes centred on the learners; what rich experiences they were able to provide which were empowering for both girls and boys; and to what extent they were able to provide a safe classroom environment within which girls and boys were able to participate, to take risks and to enjoy mathematics.

Although the research began with no definite views on what would emerge, nevertheless it was expected that certain issues might be significant. For example, that there might be tensions between the teachers' constructivist intentions and the reality of running their first full mathematics programme; and that the reality of 'being a teacher' and of belonging to an institution might create conflict between the teachers' desires to implement their beliefs and the constraints of their institutions.

Recognising, then, the complexity of classroom research, this study explores in particular, three crucial issues of influence on practice: the teachers' own beliefs about mathematics and mathematics teaching; the mathematics curriculum and its philosophy; and the professional survival of teachers. In this study, these issues are explored against a background of literature on

- constructivism and its relationship to mathematics teaching
- gender equity within mathematics
- the process of socialisation of beginning teachers
- teacher beliefs
- reflective practice as a means of enabling the implementation of espoused beliefs

- espoused beliefs as a factor in the provision of an equitable mathematics programme.

The case-study nature of this research was determined by the multi-faceted interface of these issues within the complex nature of the classroom environment.

CHAPTER 2

LITERATURE

The current climate within which mathematics teaching is promoted is that of constructivism. Constructivist theories of learning have affected the development of present-day school curricula which emphasise the learner as the key person in the learning experience and the teacher as a facilitator of tasks which allow learners to construct their own knowledge. Within the framework of constructivism and the teaching of mathematics, the review of literature discussed in this chapter focuses on two aspects: the mathematics environment within school classrooms and the socialisation of beginning teachers into their institution.

2.1 CONSTRUCTIVISM

A philosophical background

One of the most influential factors of constructivist theory is that, in a learning situation, the focus of knowledge acquisition is transferred from the teacher to the learner. Two tenets of constructivism arising from the theories of Von Glasersfeld (1989: 162) are:

> Knowledge is not passively received but actively built up by the cognising subject.

> The function of cognition is adaptive and serves the organisation of the experiential world, not the discovery of ontological reality.

Theories about the acquisition of knowledge and about knowledge itself have emerged from these two principles. Ernest (1992) describes three paradigms which fit a constructivist philosophy, namely trivial, radical and social constructivism. They all share the core idea that knowledge cannot be transmitted directly from teacher to learner but that it is constructed by the

learner. However, they differ in their claim of what that means with respect to the knowledge itself.

Trivial constructivism embraces the first of von Glasersfeld's principles only; that is, it embodies the belief that learners construct new knowledge themselves but trivial constructivists claim that knowledge is a multitude of already existing facts and truths. This means that all knowledge, although constructed by the learner, is constructed to match the world (Ernest, 1992). Thus, in mathematics, all knowledge constructed is fitted to an already existing body of truths.

Radical constructivism is seen to encompass both of von Glasersfeld's principles. Radical constructivists believe that constructs are individual to each learner and that the experiences and perceptions of learners are crucial to the construction of a world unique to each learner. In mathematics, the individual therefore constructs her own body of knowledge which may or may not bear any resemblance to that of another individual (von Glasersfeld, 1990a). However von Glasersfeld (1990b: 28) does emphasise that

> ... radical constructivism does not suggest that we can construct anything we like, but it does claim that within the constraints that limit our construction there is room for an infinity of alternatives.

Within the paradigm of social constructivism, followers believe that "there is a world out there.......but we have no certain knowledge of it" (Ernest, 1992: 8). From acknowledging social constructivist beliefs then, arises the concern that individual constructions would lead to individual and differing views of possibly differing worlds. This leads social constructivists to support the importance of social interaction within the learning situation. It is this

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interaction with others which gives way to negotiated meanings and interpretations of a shared world. For the learning of mathematics, this means that there is no privileged vantage point (Ernest, 1992), that within this community of practice there is no single correct representation of a truth but instead reality "is conceived as complex, multifaceted and multidimensional" (Keiny, 1994: 158).

The challenge for school mathematics is the degree to which teachers are able, or willing, to accept these paradigms. While recognising in von Glasersfeld's first principle above that constructivism suggests new theories about the way students acquire new knowledge, there are difficulties with acceptance of the second principle: the very existence of a prescribed curriculum seems to contradict the notion that there is no given set of knowledge.

This study is concerned with the effects on beliefs formed during pre-service teacher education, based on the philosophies upheld by these paradigms.

2.2 CONSTRUCTIVISM AND THE MATHEMATICS CLASSROOM

Growing numbers of educationalists see themselves as classroom constructivists to a greater or lesser degree of commitment. Despite the claim by Niesser (1967, cited in Noddings, 1990) that all mental processes are constructive and therefore all learning lends itself to a form of constructivism, be it through weaker or stronger acts, the current challenges to teachers of mathematics whose beliefs fit within a constructivist framework are threefold: 1) a redirection of focus from the teacher to the learner and the learner's experiences, in the acquisition of knowledge 2) the acceptance of the learner's view of the knowledge and 3) the assessment of the learner's self-constructs.

Acquisition of knowledge

Constructivist theory challenges teachers to value the contribution of the learner in the learning process. Begg (1995a) reminds us that constructivist theories are about knowledge and how people 'come to know', rather than theories of teaching and that constructivism is merely one paradigm within which the process of learning can be defined, while Leder (1993: 12) espouses the notion that learners

> actively and uniquely construct knowledge within the framework of their own experience, rather than passively receiving information transmitted by textbooks or teachers, is accepted by those working within a constructivist paradigm

What are the challenges then, for the teacher who believes in the learners' active construction of mathematical knowledge? In considering the role and expectations of the mathematics teacher in the constructivist learning process, Mayers and Britt (1995: 62) categorise the challenges as

- creating a problem-solving atmosphere
- facilitating the mathematical 'talk'
- creating an appropriate social climate
- developing learning situations ... accessible to ... a range of conceptual levels

In order to facilitate a 'constructivist' classroom, to allow for the demands as described by Mayers and Britt, the programme needs to be arranged around open-ended tasks which allow the learners to explore the concepts for themselves. Steffe and Kieren (1994: 21) call these tasks "spaces for experiences ... (which have) no pregiven prescribed ends"; tasks which provide teachers with the opportunity to observe, listen and question. For children to

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experience the opportunity to think about their mathematical ideas most effectively within their spaces of experience, Steffe and Kieren claim that the tasks must be well-defined. Shiu (1995) identifies a difference between task and activity as the presentation by the teacher compared to the actions taken by the children and stresses the importance of planned tasks which encourage appropriate student activity. Ahmed (1987: 20) describes the attributes of tasks which encourage rich mathematical activity in the children as tasks which should

- be accessible to everyone at the start
- allow for further challenges
- invite children to make decisions
- involve children in speculating, hypothesis making and testing, proving or explaining, reflecting, interpreting
- encourage searching in other directions
- promote discussion and communication
- encourage originality/invention
- encourage 'what if' and 'what if not' questions
- have an element of surprise
- be enjoyable.

Just as the nature of the task plays an important part in the acquisition of learning, so too does the process. In problem-solving, constructivism validates intuition or the ability to try different paths. For the constructivist, a problem is open to different interpretation by each solver. Confrey (1991: 117) states that "a problem is only a problem to the extent to which and in the manner in which it feels problematic to the solver". Constructivism has motivated teachers to allow children choice, real choice, to interpret problems in their own ways and to use one or more of a variety of means to help find a solution.

Working within a constructivist framework in the mathematics classroom allows the teacher to set up a problem, to leave the learners to explore the problem for themselves, and to support the learning through scaffolding (Vygotsky, 1978): questioning, probing and negotiating meaning with the learners. Negotiation about facts which, although they may already exist, may be viewed differently through the eyes and experiences of the learner, requires the teacher to be a true participant in the negotiating process and this has real implication for the teacher as learner, as opposed to the teacher as giver of knowledge. Constructivism challenges the teacher belief that mathematics learning is linear and requires teacher-control. Removing the ceilings to learning and providing tasks which encourage the learners to adopt for themselves a 'top-down' approach to problem-solving allows the learners to not only experiment with manipulative or concrete materials but also to develop and re-organise their own mental constructs (Piaget, 1965; Bird, 1992).

The current study explores the strategies used to meet the challenges of providing appropriate tasks to teach mathematics according to constructivist beliefs.

Mathematical knowledge

A second challenge for the constructivist teacher is the question of the mathematics itself. The very existence of content-inclusive curricula implies the continued need for school mathematics to be based on a given set of truths. However, challenges from radical constructivists have provided mathematics educators with the opportunity to explore the question of what comprises mathematical knowledge; whether construction of knowledge leads

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to ownership of the mathematics itself and whether concepts of mathematics can be open to negotiation between learner and teacher.

"The construction of new understandings is stimulated by a problem situation, that is a situation which disturbs the individual's current organisation of knowledge" (Simon & Schifter, 1991: 310). This statement does seem to challenge the existence of the knowledge itself and while the constructivist challenge to the very existence of a given body of mathematical knowledge may be too strong for school mathematics, there is however, a move within constructivist thinking which recognises that mathematics is broader than the accepted given set of truths; that the truths are embedded also in the processes of doing mathematics (Hagg, 1991; Neyland, 1994). Romberg and Carpenter (1986) describe the traditionalist view of school mathematics as both static and bounded, as compared with the constructivists who believe in openness as described by Lakatos (1976): that scientific enquiry begins and ends with problems.

For school mathematics then, constructivism is not the study of reality but the construction of reality (Steffe & Kieren, 1994). A study of the ways in which children construct and organise their mathematical ideas provides teachers with the possibility for linking the 'children's mathematics' to the already existing central concepts of mathematics (von Glasersfeld, 1990a; Steffe & Kieren, 1994). In this way children not only construct powerful mathematical ideas for themselves but they also come to recognise their own power as thinkers and learners of mathematics (Simon & Schifter 1991).

A study by Maher and Davis (1990) highlighted the situation where the teacher's representation of a problem is in conflict with that of her students'. The study discloses the difficulty of working with the student's ideas when

these ideas are at first seen to be a misrepresentation of the problem and describes how a teacher continues to find out as much as possible about students' ideas in order to understand their thinking and to develop their thinking further. The directions in which the children's thinking is developed are the acceptable directions established within the community of mathematicians, from 'children's mathematics' to established concepts (Steffe & Kieren, 1994). Romberg (1993) positions his views on how students 'come to know' within the broader question of what knowledge any particular educational community wants its students to have. One of the biggest adjustments for mathematics teachers then, intent on providing for constructivist learning, is to not only accept the contributions of the learners but also to legitimise their thinking.

Recommendations within the current mathematics curriculum (Ministry of Education, 1992: 11) such as

- (Concept learning) should be taught in such a way that students develop the ability to think mathematically ...

- Students learn mathematical thinking most effectively through applying concepts and skills in interesting and realistic contexts which are personally meaningful to them ...

- Rather than remembering the single correct method, problem solving requires students to search the information for clues and to make connections to the various pieces of mathematics and other knowledge and skills which they have learned ...

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- Critical reflection may be developed by encouraging students to share ideas, to use their own words to explain their ideas, and to record their thinking in a variety of ways ...

- As new experiences cause students to refine their existing knowledge and ideas, so they construct new knowledge ...

would suggest that the curriculum has constructivism as its underlying philosophy. What does this mean in terms of mathematics knowledge and what are the implications for the classroom teacher?

Teachers of mathematics are "being encouraged increasingly to adapt curriculum content and classroom practices in order to recognise students' prior experiences" (Mousley, 1993: 326). Mayers and Britt (1995: 66) recommend that "Just as constructivism requires students to take responsibility for their own learning, (so should) teachers take responsibility for their own teaching." Steffe (1990) recommends that teachers should reject the traditional 'top-down' approach to classroom teaching which pre-determines the levels of concepts exposed to the learners and instead should use the curriculum to construct a network of mathematical concepts which will allow the learners to use a variety of concepts, thus constructing their own curricula. Mayers and Britt describe this adaptation of a prescribed curriculum as teachers not viewing the curriculum " ... as a fixed entity, ... (but as) starting points that must undergo transformation during actual teaching."

Implications for the current study arise from the constructivist assumption that the learners need to be actively involved in the learning, " that an acceptance of constructivist premises about knowledge and knowers implies

a way of teaching that acknowledges learners as active knowers" (Noddings, 1990: 10).

Assessment within a constructivist paradigm

A third challenge for the constructivist teacher is providing assessment which reflects not only what learners know but how they come to know, and this is well-documented (Carpenter & Fennema, 1991; Confrey, 1991; Begg, 1991, 1995a, 1995b; Mousley, 1993; Romberg, 1993). Traditional assessment tasks have been behavioural in nature, contradicting the accepted notion of constructivism that process is as important an aspect of learning as product. The quality of the mathematics learning that is valued within a constructivist paradigm should be reflected in the assessment of the knowledge (Clarke, 1995). The difficulties of providing non-behaviourist assessment which does value constructivist learning principles is discussed within a New Zealand context by Neyland (1995). Neyland contrasts the social constructivist principles of the current mathematics curriculum (Ministry of Education, 1992) with New Zealand's current neo-behaviourist education environment which views knowledge as a body of facts, concepts and skills to be learnt, performed and checked off.

Romberg (1993: 109) describes "authentic performance assessment " as defined by Lajoie (1992) in keeping with constructivist theory. Authentic assessments should measure the degree to which each student has shown her ability to solve non-routine problems and to apply mathematical ideas to a variety of related situations. Tasks are defined as complex in nature with students expected to work on them for some period of time before submitting their responses. These responses should contain not just answers but arguments which describe conjectures, strategies, and justifications.

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Assessment of personal knowledge and understanding gained from these tasks has raised concerns across the international mathematics education community (Begg, 1995b). One effect of constructivist thought on assessment is an increased focus on informal assessment. In terms of monitoring student progress, exploration into constructivism has enabled teachers to think about their questioning and to assess a broader range of mathematical skills (Ministry of Education, 1992). With an emphasis that formal assessment tasks, also, should measure understanding rather than recall of facts (Romberg, 1993; Begg, 1995a), Lampert (1991) questions what students' understanding could look like. Assessment methods which measure understanding should involve greater, more real, participation of the learners. Children are good judges of what they find problematic and it is suggested that the learners themselves could be asked to describe ways in which they tackle and solve assessment problems, or asked to look for patterns or trends in problems which cause difficulties (Carr & Ritchie, 1991; Cobb, Yackel, & Wood, 1991). In the Netherlands currently, one initiative allows the students to spend time researching and solving given problems in preparation for presentation and dialogue with their teacher (Begg, 1995b). Successful assessment of an interactive nature is dependent on teacher-confidence in terms of when and how much intervention is a measure of student understanding in contrast to the traditional assessment methods which demand that students demonstrate skills with no teacher intervention whatsoever (Lampert, 1991). It must follow then, that teacher-confidence could be a necessary component of increased effective teaching within a constructivist environment.

A constructivist approach to assessment has led to greater recognition of group assessment tasks whose validity is supported by social constructivist beliefs. Simon and Schifter (1991: 310) write

As group meanings are negotiated, group members engage in making sense of and resolving disequilibrium caused by differences between their ideas and those of others. Thus, cognitive reorganization is promoted by these attempts at communication and cooperation.

Assessment within a group situation provides the teacher with opportunity to assess the strategies students use to learn from their peers' ideas and to change their thinking accordingly. As an individual group member makes sense of the explanations of others, it should be possible for their own understanding to be assessed (Yackel, Cobb, Wood, & Merkel, 1990). Assessment of the interactions within the group allow teachers to measure the doing of the mathematics, the changes in direction, and the switching of strategies, as well as the mathematics content itself (Carr & Ritchie, 1991; Hagg, 1991).

No discussion of assessment could be complete without raising again the question: what is mathematical knowledge? Romberg (1993) views knowledge in terms of three components: students' prior knowledge; students' own perception of the mathematics; and society's expectations of mathematical concepts. Assessment tasks should measure a student's real contribution by valuing the manifested mathematics in terms of both accepted and personal mathematical knowledge. Criteria for assessment should measure not only demonstration of established 'public' mathematics but also of the processes by which the knowledge was gained. In this way a student's interpretation of, and attempts to make sense of, the expected mathematics would receive recognition.

The provision of a collection of tasks which encourage learner participation is insufficient evidence of a constructivist classroom environment. The current

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study explores to what extent first year teachers are able to devise and use methods of assessment which address the broader issues of constructivist learning.

2.3 LEARNING TO TEACH FOR CONSTRUCTIVIST LEARNING

A recurring situation for teacher educators is to find ways of developing more effective teachers. Teachers describe effectiveness in the classroom as success in developing their pupils as learners (Keiny, 1994). A belief in constructivism acknowledges that the learner has a greater part to play in the acquisition of his own knowledge. For teacher education, this suggests opportunities for pre-service teachers to not only address the theoretical aspects of constructivism but also to experience for themselves the benefits of socially constructed concepts.

One way of providing these opportunities is described by Condon, Clyde, Kyle, and Hovda (1993). They report on a pre-service teacher education programme in which the students were encouraged to build from their previous academic and career experiences, and to take risks as learners. Amongst their findings, of particular relevance to the current study, was the students' desire to "view learner-centeredness as an essential quality of their teaching" and the growth in their ability to make informed decisions. In exploring what students claimed to have learned from their teacher education programme, the study described student-responses with respect to each of these strengths. Condon et al. (1993: 275) describe how students placed emphasis on the importance of "building on children's needs and interests; providing choices, freedom and responsibility to children; adopting a facilitation role; involving the children in the lesson(s); and including manipulatives or other hands-on materials" and secondly through assuming the role of teacher-researcher, students developed confidence in using

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"information gleaned from observing children in making informed decisions about how to address their instructional needs."

As in further studies (Keiny, 1994; Mayers, 1994), the above study illustrated that a constructivist approach to a pre-service teacher education programme changed the behaviour patterns traditionally associated with teacher/children role. Condon, Clyde, Kyle, and Hovda (1993: 276) claim that the results of their programme contradict the notion that beginning teachers become passive technicians who replicate pre-packaged instructional programmes. Highlighted are the shifts in student concerns, from issues such as "right answers, discipline and grading" being replaced by "love of learning, ethics, getting (children) to think, and different learning styles." (Condon et al., 1993; Keiny, 1994) have found that constructivism's focus on the process of arriving at the knowledge enables teachers to be better able to cope with the complexities of classroom teaching.

Teacher-education programmes which are developed within a constructivist framework provide opportunities for reflection as a tool for communication. In particular, shared or interactive reflection allows the exchange of situational descriptions and personal ideas to become decontextualised. This can then lead to a social construction of theoretical knowledge of a more abstract nature (Bell, 1993; Keiny, 1994). Shulman (1987) categorises the acquisition of knowledge about becoming a teacher into four parts: comprehension, reasoning, transformation and reflection, and he emphasises particularly, the place of intellectual thought, or reflection, within the preparation for effective practice.

Consistent with Vygotsky (1978), who emphasises the dynamic support of a teacher for a learner, within the learner's "zone of proximal development",

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Laurenson (1995: 2) defines teaching as involving "a person who knows something about a concept, interacting with a group of persons who do not understand the concept". This definition fits the paradigms of either trivial or social constructivism, in that it assumes the existence of some sort of body of knowledge. Teaching though requires pedagogical as well as conceptual knowledge and his study into the beliefs and practices of teachers of mathematics explores both these directions. A constructivist approach to pre-service teacher education led to the provision of programmes which relate subject and pedagogical matter by embedding the subject matter into a pedagogical context (Cobb, Yackel, & Wood, 1991; Cochran, DeRuiter, & King, 1993; Britt, 1995). The acquisition of content knowledge integrated with the development of pedagogical concepts allows the issues of learning and teaching to develop as part of an important wholeness.

Of importance to the current study is that the beginning teachers in the study had experienced mathematics programmes within pre-service teacher-education where content was taught within a pedagogical context.

2.4 EQUITY AND EQUALITY

According to dictionary definition, equality is the condition of being equal to, or the same as, another person while equity is fairness, or the application of principles of justice in order to produce fairness (McIntosh, 1950). People are different, in personal culture, in ethnicity and in gender, and their differences may or may not be relevant within a particular context. Bennison, Wilkinson, Fennema, Masemann, and Peterson (1984) define a social justice model for learning within which both the differences and similarities of people can be catered for. In particular they see in this model that by respect for, and fair treatment of, relevant differences, justice can be achieved.

Gender equity and mathematics education

In terms of gender and mathematics education, the relationship between equity and equality has implications for schooling and in particular, for mathematics learning. Advertising for a well-known encyclopaedia publication states "Knowledge is power". Mathematical knowledge, in particular, is still regarded by society as an essential pre-requisite for entry to positions of power (Mayo, 1994). In order to achieve a balance of power, in terms of gender, learners of mathematics need to have experienced equitable conditions throughout their schooling. Studies on the provision of gender-equitable conditions in the mathematics classroom report a resulting increased access to, and enjoyment of, mathematics by females (Barnes & Coupland, 1990; Verhage, 1990; Jones & Smart, 1995). An equitable mathematics classroom climate is essential in order to provide females and males equal opportunity to enter the future of their choice (Fennema, 1990b).

A diversity of perspectives

Gender equity issues within mathematics education have received considerable attention over the past two decades. According to Jacobs and Wigfield (1989: 40), research on gender equity issues in the mathematics and science classroom can be divided into three categories:

- person-centred research, focusing on characteristics and interactions of students and teachers
- instructional context research, focusing on how tests, instructional materials, and the structure of the classroom environment influences student achievement
- macrolevel demographic research, emphasizing enrolment patterns ... and choices of different occupations.

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In the first category are studies focusing on differences in performance between females and males at a variety of educational levels and in many parts of the world. For example, relativity of the attainment at primary school in terms of the types of questions tested (Shuard, 1983); differences in use of spatial visualisation skills at the sixth and eighth grades (Fennema & Tartre, 1985); comparative analysis of performance in the New Zealand Universities Bursary examinations (Reilly, B. J., Reilly, I. L., Pemberton, & Lee, 1987; Morton, Pemberton, Reilly, B. J., Reilly, I. L., & Lee, 1988; Forbes, 1988); comparative performance on basic skills testing of children in years 3 and 6 (Barnes, 1990); longitudinal development of number knowledge in children aged five to nine (Young-Loveridge, 1991); differences in year Five and Six children on pencil-and-paper items (Bishop & Clements, 1994); differences in performance of Chinese middle school students (Turner, 1994); analysis of examination results for first and second year university students (Blithe & Clark, 1995). These have led to studies focusing on the assumed differences in characteristics and attitudes of females and males and to the subsequent behaviours of teachers (Hart, 1989; Leder, 1990; Forgasz, 1995; Taole, Zonneveld, & Letsie-Taole, 1995).

In this category also are studies which indicate some of the characteristics of girls and boys as constructed by society. The attitudes of learners of mathematics can be polarised according to gender and one example of this polarisation is the differences in confidence levels of female and male learners (Clark, 1994; Fennema, 1993). Clark reports on the attitudes of the learners themselves: how the boys attribute poor results to extraneous factors beyond their control while girls tend to blame themselves. Meanwhile Fennema looks beyond the learners, to the teachers, and writes that they also attribute boys' success to ability and girls' success to personal effort.

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The second category includes intervention programmes which were introduced in order to raise the achievements of girls and further studies reported the success of some of these (Meade & Staden, 1985; Kreinberg, 1989; Rowe, 1990; Inkpen et al., 1994; Taole et al., 1995). However, the framework used for research of this nature has as its base measure the performance and achievement of males and approaches the female situation from the perspective that 'There's something wrong with the girls. What can we do to help the girls catch up with the boys?' In a summary of research paradigms Leder (1995) describes how this deficit perspective, while resulting in the removal of some of the barriers, also means that the true path to equity is still often seen as one of resocialisation, of socialising the females into a male mathematical domain. This socialisation process is described by Pollina (1995: 30) as putting girls through "courses in remedial masculinity" in order to support their survival in a male world.

In exploring the third category, calling it demographic research, Jacobs and Wigfield (1989) report on studies which explore the gendered participation of school programmes. The lower participation rates for females led them to follow up with investigations into programmes designed to promote gender equity by exploring 'how it really is' for females and their mathematics education. They report on projects which present mathematics and science programmes with appeal for both girls and boys. The planning for these programmes was based on research into students' already-held views and attitudes towards these subjects (Kelly, 1984; Smail, 1984). Researching the lived reality for girls in the mathematics classroom poses such questions as: is it the actual mathematics rather than the girls which needs the focus? does the mathematics itself pre-determine a marginalisation of female pupils? is the assessment fair for all students? is it the prevailing gendered practice of mathematics pedagogy that needs reform? (Willis, 1989, 1992;

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Zevenenbergen, 1993a; Blithe, Clark, Forbes, S., & Forbes, R., 1994; Atweh & Cooper, 1995; Solar, 1995).

Whatever the paradigm, the basis for research into success in mathematics education for all learners, and especially girls, is that mathematics teaching should provide equitable access to the knowledge because mathematics is a "sieve which keeps power with the groups who succeed at it" (Mayo, 1994: 291). Successful experiences which lead to fuller participation is essential as those who do not succeed in school mathematics do not necessarily have the same access to power in society. With power comes the opportunity to make decisions, and to affect change in society to the advantage of the power group. The polarisation of those with and without power, in terms of gender, could be decreased if girls and women were less marginalised by their mathematics education (Fullerton, 1993).

2.5 EQUITY IN THE MATHEMATICS CLASSROOM

> The way the classroom is managed is an important factor in all students' experiences of learning. Schools should be aware of the needs of girls in the decisions they make about the way classrooms operate. Classroom rules, tasks, routines, teaching methods, learning resources, the language the teacher uses, evaluative criteria used for assessment, and the arrangements for seating and work areas should be examined to make sure that they do not militate against girls' performance.
>
> (Education Review Office, 1995: 23)

Several studies discuss strategies for the promotion of effective gender-equitable programmes in the mathematics classroom (Isaacson, 1988; Willis, 1989; Fennema, 1990a; Zevenbergen, 1993b; Solar, 1995). To address the issue of justice in the mathematics classroom, Isaacson writes that, in order

to counter the social conditions which compound to disadvantage girls in mathematics, teachers should endeavour to counter these discriminatory 'social' factors, while Willis stresses the implementation of classroom programmes which increase girls' access to the actual mathematics. In terms of teaching strategies, this includes a real valuing of the experiences of the learner in both the development and in the assessment of the concepts. In exploring the different messages that girls and boys can receive in the mathematics classroom, Zevenbergen discusses how the effects of classroom discourse can produced gendered learners, while Fennema explores the effects on gender equity of teachers' beliefs by identifying the critical contribution of a teacher's belief structure on the classroom environment. Solar, in turn, (citing Solar, 1992: 314) focuses on the apparent changes for females engaged in an inclusive curriculum:

- from silence to speech
- from passivity to active participation
- from powerlessness to empowerment
- from omission to inclusion.

Gender as a culture

The view that mathematics cannot be separated from the values and experiences of those doing the mathematics is now recognised within the research framework of ethnomathematics (d'Ambrosio, 1990; Bishop, 1993; Barton, 1993) with the proposition that it is possible to argue mathematics from simultaneous perspectives. Haynes (1994) writes that within this dynamic framework, where the construction of knowledge and understanding are built through the cultural capital provided by the learner, there are implications for all learners; and in particular, within the traditional male domain of mathematics, for the female learner.

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In the current teaching environment where the valuing and communication of the learner's ideas is rated highly, Burton (1995) stresses that there can be increased access for all learners, only if the assumption that there are only essential truths in mathematics is challenged. She characterises the nature of mathematics as a set of male truths and states her hope that if the mathematics itself is open to the influence of members of as many different communities as possible, then not only will the individuals be enriched but so might mathematics, itself, look different. Burton's belief is consistent with Fennema (1993) who put forward the view that a feminist perspective on mathematics epistemology and pedagogy, which emphasises the need for female teachers and learners to have maximum access to mathematics learning, could have an influence on both mathematics and mathematics education.

Despite moves to accommodate the individual within the mathematics classroom, differences in the already constructed persona of both learners and teachers continue to give rise for concern about the inequity of access to learning between girls and boys. However, Hanna (1994: 304) who, in reviewing the variety of historical perspectives on gender and mathematics learning, espouses her belief that "... there is only teaching and better teaching, rather than teaching that is specific to girls or boys ..." and she emphasises a focus on the needs of the individual rather than on differences in gender.

Having constructivism as its theoretical base, the current study explores whether constructivism can, in fact, serve as a useful paradigm for advantaging the mathematics experiences of girls without disadvantaging the learning experiences of the boys. It explores the extent to which teachers are able to 'control' for equity within primary co-educational classrooms.

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2.6 THE BEGINNING TEACHER

Classroom practices of beginning teachers

Studies of beginning teachers often reveal that their classroom practices are conservative and conventional. Kuzmic (1994) cites earlier studies which have shown the lack of inspiration (Wright & Tuska, 1968), the custodial style of management (Hoy, 1968) and the authoritarian stance (Ligana, 1970), present in the classrooms of first year teachers. In a study which investigated beginning teachers' ability to put into practice key skills they had believed in as final year students, Rose (1993) reports that, in the reality of the classroom, some skills were more difficult to maintain than others.

In their study of the classroom practices of beginning teachers, Sullivan and Leder (1992) report that in contrast to the above studies they found that novice teachers exhibited many of the characteristics of quality teaching. Reporting on one of two case studies of first year teachers, Sullivan and Leder noted that "the content was substantial, the class well-organised and well-managed, and appropriate aids that were directly related to the task were used" (Sullivan & Leder, 1992: 632). In the second case, they reported that the teacher "felt a strong need to make mathematics real and to use concrete aids to explain processes to the children" (Sullivan & Leder, 1992: 636). These findings are supported by Kuzmic (1994), whose case study of a beginning teacher showed that her desire to provide a positive experience for the children was reflected within the classroom in her curriculum implementation, through her interactions with the children and by her organisation and structure of the school day.

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The current study will explore whether the classroom practices of beginning teachers do in fact match their desires to provide a positive and enjoyable mathematics experience for the children.

Influences on the beliefs and practices of beginning teachers

There are potentially many influences on beginning teachers. These include their own schooling and family background, teacher education courses, the process of the transition from student to teacher, the school in which they will teach and its associated induction programs, and the classroom itself.

(Sullivan & Leder, 1992: 621)

Sullivan and Leder group these influences into three categories: influences prior to teaching; influences in the school; and influences in the classroom. As well as the influences from a variety of aspects of their pre-service teacher education courses, some of the major influences investigated by Sullivan and Leder (1992) were the teachers' own school experiences, and the demands of the variety of clients to be satisfied once in the job, such as the school principal, supervising teacher, and parents. Content knowledge and teaching resources were also regarded as influential on the teachers' practices.

Sullivan and Leder (1992: 639) reported that

None of these factors emerged as having an important influence on these beginning teachers. Indeed, all seven teachers felt that they were given little support or direction from the principal, the school, the parents, or other teachers. Nor did the beginning teachers believe that the academic components of their teacher education program had influenced their teaching.

They found that the influence foremost in the teachers' thinking was their students' responses to their teaching. The teachers stated that student

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response to instruction affected their planning, implementation and evaluation of classroom events.

The influence of the process from student to teacher during pre-service teacher education does not seem to be as effective as teacher educators would hope. According to Rust (1994: 216), first-year teachers enter the classroom

> feeling more, or less, competent to teach the various areas of the elementary curriculum but largely unaware of those organizational, administrative, and interpersonal forces that are likely to influence their lives in schools.

In contrast, Renwick and Vize (1993) found that the perceived value of the pre-service teacher education of beginning teachers in their study included the acquisition of knowledge about not only the school curriculum but also about planning, organisational and management issues.

Veenman (1984), reviewing studies on the perceived problems of beginning teachers, identifies how person-specific and situation-specific issues exert different influences on first year teachers. Similar findings are reported by Koehler and Grouws (1992) in their synthesis of research into mathematics teaching practices where they classify studies according to a variety of influences on the teacher and her practices. In order to examine all aspects of the classroom climate, Veenman suggested at that time that research was needed into the variety of ways in which training and assistance could support the beginning teacher. Meanwhile, Koehler and Grouws recommended that further research should include an examination of the effects on the classroom climate of teachers' personal characteristics, teachers' knowledge of content and pedagogy as well as student-teacher interaction.

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Some of these possible influences were investigated in the current study. The categorising of influences were of particular value although this study categorises the influences on the classroom practices of beginning teachers before, during and after their pre-service teacher education rather than before teaching and during teaching. Two questions in the current study investigate which influences from their pre-service teacher education are thought to have been effective on teachers' classroom behaviour; and the extent to which the teachers would feel that they had been prepared for the totality of classroom teaching (Lortie, 1975).

Socialisation into the institution

Within the context of curriculum-implementation Walshaw (1994: 65) found that "teachers *can* be simultaneously responsive to autonomous professional practice ... and to the institution." The extent to which the socialisation into a school environment, with its own culture, beliefs and expectations, can help or hinder this response in terms of practice, is an important issue during the first year of teaching due to the vulnerability often felt by beginning teachers on first entering an institution.

Lacey (1977) developed a framework for defining the extent to which a person is socialised into individual institutional situations. His model of social strategies comprises three distinct situational reactions: internalised adjustment, strategic compliance and strategic redefinition. Using Lacey's model for a study on the socialization of beginning teachers, Zeichner and Tabachnick (1988: 9) develop these strategies and describe them as follows: in the first case internalised adjustment means "a response where individuals comply with the authority figure's definition of a situation and believe these constraints to be for the best"; in the second case strategic compliance is defined as "instances where individuals comply with the constraints posed by

a situation, but retain private reservations about doing so" and thirdly, strategic redefinition they see as "situations where successful attempts to change are made by individuals who do not possess the formal power to do so". In the latter, attempts are made to widen the range of acceptable behaviours in a situation and to introduce new and creative elements into the school setting. From the findings of their two-year longitudinal study of the development of teaching perspectives of four beginning teachers, Zeichner and Tabachnick (1985) also challenge the accepted view that beginning teachers are particularly vulnerable to institutional forces. They found that beginning teachers can demonstrate resilience and firmness when under pressure to change.

Exploring survival strategies used by pre-service teachers Goodman (1988: 31) identified five political tactics which the teachers developed, during a full semester in the classroom, in response to institutional expectations which prevented them from implementing programs in keeping with their beliefs. She labelled these five levels of compliance as overt, critical, accommodative resistance, resistant alteration and transformative action. Findings revealed that all teachers used the first four tactics and all but one used all five tactics. Furthermore the use of less compliant tactics increased with time.

The overt tactic was characterised by the desire to fit into the procedures of the school and was demonstrated more frequently at the early stages of the semester. The most common tactic employed was critical compliance where the teachers "accepted the status quo by teaching their lessons in the traditional manner. However, they were at the same time critical of these instructional programs".

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During the accommodative resistance phase, while teachers did comply with the expectations of the school they prevented these expectations from defining their own roles as teachers by "reflecting on ways to resist and perhaps alter standard procedures". They began to use strategies which made "schooling more personally meaningful to their pupils and themselves at the resistant alteration stage" and "also made decisions concerning the content taught in their lessons".

For those who went to the transformative action level, they "significantly transformed the education in their classrooms ... they seriously reflected on what should be taught to their pupils (considering the uniqueness of the individuals involved) and then planned and implemented ..." accordingly. Goodman's study, likewise, raised the issue of autonomy within the classroom and he writes

> Some educators believe that most teachers are incapable of making substantive curricular and instructional decisions ... and as a result teachers need specific direction about what to do in their classrooms.

Decision-making on programme implementation can sometimes create tension for a teacher in managing the competing expectations within a school. Sutton (1995) describes the tension for teachers when planning their programmes as they try to compromise their personal preferences with the demands of the school or team within which they work. Jones (1995), however, prefers to think of this tension as a positive force that challenges the beliefs and intentions of teachers. Jones' report on mathematics teaching supports Goodman (1988: 36), who found that when teachers were encouraged to develop into reflective and active practitioners,

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when allowed to make substantive decisions, the participants expressed a level of confidence, excitement, and creativity not found in many beginning teachers.

In using Goodman's (1988) social strategy framework to explore teacher behaviour through reflective, interactive feedback of observed classroom behaviour, the current study raises the question of whether teachers were able to avoid being socialised into conforming with every aspect of their institutions; or if their levels of socialisation were dependent on the influences of the variables within each institution.

2.7 REFLECTIVE PRACTICE

It is widely reported (Lortie, 1975;Joyce & Clift, 1984; Regan & Hannah, 1993) that beginning teachers find it difficult to resist pressures to conform to institutional norms for teacher behaviour. However, Kuzmic (1994) writes that, given the opportunity to be reflective, active and thoughtful about their teaching and the process of becoming a teacher, some teachers do not adopt this pattern. In an ethnographic study of a first year teacher he found that throughout the semester in which he researched her progress, she demonstrated a strong commitment to her beliefs and successful implementation of them in practice. Data was collected through a combination of field observations and interviews as well as the journal kept by the teacher. By providing her with the opportunity to reflect on her practice through interactive discussion, he maintains that the process of becoming a teacher was able to be explored from the vantage point of the beginning teacher.

Pultorak (1993) identifies two conditions which make the practice of reflection difficult for teachers, calling the first constraint cognitive and the second organizational. He states that the ability to look back and learn from

one's experiences within a classroom environment, a cognitive constraint, is extremely complex and difficult to acquire, while he particularly highlights the difficulty of finding structured opportunities within which to reflect, as an organisational constraint. However, recognising reflective practice as an important aspect of teacher education, Pultorak conducted a study addressing the facilitation of reflection in the practice of novice teachers. Two of the procedures commonly used in studies on classroom practice are journal-writing and lesson-observation. However, a third procedure involved the teachers visiting other classrooms and reflecting on the success or otherwise of the event, in terms of a pre-determined goal or purpose. The reflective analysis included three phases: a reflective interview in which the teacher was asked to reflect on the lesson in terms of a planned sequence of questions; descriptive feedback during which the teacher was given written feedback on the lesson; and a prescriptive focus during which the teacher and the observer collaboratively determined an area for follow-up.

The analysis of the reflection that occurred was categorised according to a model developed by Van Manen (1977). Van Manen suggested that reflection occurs at three levels: technical rationality which focuses on classroom competency and effectiveness demonstrated by measurable outcomes; practical action where the teacher analyses behaviours in terms of a value commitment to some belief framework; and critical reflection in which the teacher incorporates moral and ethical criteria such as whether important human needs are being met. Pultorak preferred to label these as 'categories' rather than as 'levels' in order to avoid an implied hierarchy. In exploring Van Manen's categories of reflection with the novice teachers, Pultorak identified differences in feedback depending on the different procedures used for reflection, as described above. He found that the self-reflection through journal-writing produced patterns and trends which pertained to teacher

competency and student performance while the journals arising from classroom observation of others elicited reflectivity within some definite belief framework. However, the reflective interview seemed to obtain reflective comment which was more inclined to include information such as moral and ethical considerations.

In a synthesis of research into mathematics classrooms, Mousley (1992: 96) asks the question "when does reflective practice become 'research'?" She writes that when teachers are active participants in research projects within their own classrooms, the resulting changes are more effective. Allowing teachers to research their own beliefs and classroom practices characterises the teacher-researcher as not simply a consumer but a producer of knowledge (Stanic, 1989). In describing the strengths of a teacher-researcher Mousley citing Pateman (1989: 36) writes

> Such a teacher is guided in the practice of teaching by the
> results of his or her own classroom research and does not rely
> exclusively on the results of others.

Mousley (1992: 102) describes how a mathematics teacher attempted to move towards a more constructivist style of teaching by reflecting on his actions and exploring the relationship between his perceived actions and his beliefs. This reflective research led to a

> gradual reconstruction of the teacher's central concepts of
> teaching and a greater understanding of those strategies which
> can assist the development of a student-centred style of
> teaching.

The ability to recall 'critical incidents' and to step outside them is an essential of reflective practice and teachers should be encouraged to be integrally involved in this way in order to study their own classrooms (Lerman, 1994).

Britt, Irwin, Ellis and Ritchie (1993) report on a study designed to support teachers through providing a structure within which the teachers could reflect on their classroom programme. The findings from this study emphasise that classroom experimentation together with opportunities to reflect on this experimentation is an essential for change. However, the results also suggest that experience determines whether teachers were more likely to benefit from the process of this reflective structure.

In the current study teachers were interviewed within structured reflective situations and they used the opportunity to set their own goals for further observation and reflection, within the belief framework of constructivism. As the participants had all experienced a pre-service background focused strongly on reflective practice the study hopes to determine whether a structured reflective environment during the first year of teaching enables beginning teachers to overcome some of their institutional constraints and whether different modes of reflection produce emphasis on different classroom variables.

2.8 BELIEFS AND PRACTICES

Underhill (1988) cited in Laurenson (1995: 5) defines a belief as "an attitude consistently applied to activities in which the person holding the belief is engaged". Implications for teachers are that perceptions are influenced by beliefs (Hollingsworth, 1989; Adey & Shayer, 1994) and that the nature of a belief impacts on instruction (Grouws, 1991). Hollingsworth, in particular, suggests that in a teacher-education programme, pre-service teachers will accept the ideas that are compatible with already existing views and reject those which are not in keeping with their own beliefs. This constructivist position on human learning enables the teachers to restructure their thinking

and adjust their beliefs. Grouws focuses on the impact of a teacher's beliefs on classroom instruction and his study raises the issue of the complexity of the transfer of belief into practice. He identifies within this transfer the teacher's beliefs about learners, their own conceptions of mathematics and their beliefs about the nature of instruction.

The guidelines for good mathematics teaching (National Council of Teachers of Mathematics, 1990) define a mathematics teacher's role to be:

- creating a classroom environment to support teaching and learning mathematics
- setting goals and selecting or creating mathematical tasks to help students achieve these goals
- stimulating and managing classroom discourse so that students and teachers are clearer about what is being learned
- analyzing student learning, the mathematical tasks, and the environment in order to make ongoing instructional decisions

With these goals in mind, Brown and Borko (1992) describe the Learning to Teach Mathematics Project (Borko, Brown, Underhill, Eisenhart, Jones & Agard, 1990) in which the development of 'becoming a teacher' was the focus of a study of middle-school mathematics teachers during their final year of a teacher-education program and their first year in schools. The researchers tried to explain the changes in the teachers' knowledge, beliefs, thinking and action. Questionnaires and semi-structured interviews were used to assess the teachers' knowledge and beliefs about mathematics, and the study explored the achievement of goals that were set by the individual teachers. Socio-cultural information on each school and classroom was collected to enhance the understanding of the individual environments within which each teacher was employed.

Results showed that the teachers were at different stages of development, both during their final pre-service year and later when in the classroom. Teacher-beliefs about the teaching of mathematics, and about mathematics per se, affected not only their classroom practices but also their socialisation within the institutions. A constructivist approach to teacher education programmes is suggested by a recommendation that those responsible for teacher education should assess the novice teacher in terms of their beliefs and knowledge prior to entering a pre-service programme, and that they should then provide experiences appropriate to the different levels.

Research on teachers' knowledge and beliefs has shown that espoused beliefs and intentions are not always reflected in classroom practice (Fennema & Franke, 1992; Thompson, 1992). Brown and Borko (1992) recommend that in order to help people become better teachers of mathematics, it is important to study teacher actions as well as cognitions and to identify conditions under which changes in teacher cognition are likely to be accompanied by compatible changes in the classroom.

In their model for linking the two domains of teacher-thought and teacher-action Clark and Peterson (1986: 257) support the assertion that teacher behaviour is influenced by cognition. Their model (Figure 1), while representing thought and action as two discrete domains, illustrates not only a variety of possible influences within each domain, but also the interaction between thought and action on any one of these aspects. Within each domain the cyclic nature allows for the possibility that any one category can affect either of the other two within the domain. However, the circularity emphasises that although there is a reciprocal relationship between the domains each domain can in fact exist independently of the other. One implication of this model is to what extent does reflective thought contribute

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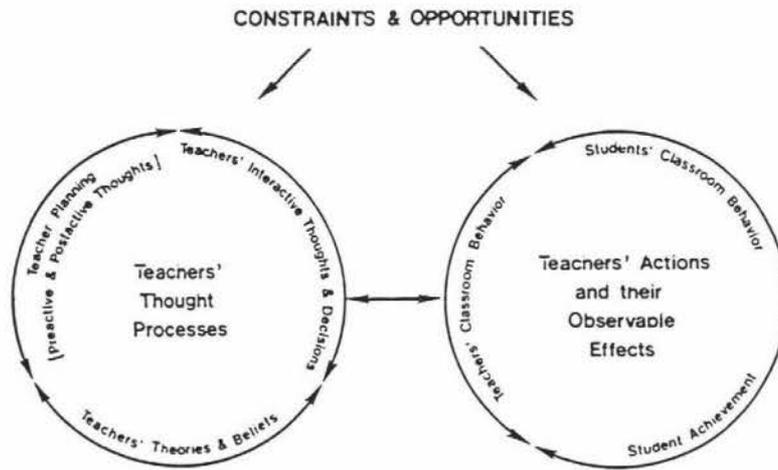
Figure 1   A model of teacher thought and action

to a teacher's belief-structure which in turn affects action. A second implication is that the inclusion in the model of 'constraints & opportunities' suggests that the constraints and opportunities within the institution do also have an influence on a teacher's implementation of ideas into practice.

The current study attempts to identify the complexity of beliefs which impact on a beginning teacher's classroom: beliefs about teaching, about the teaching of mathematics and about mathematics itself.

Beliefs and practices and constructivism

In order to reflect on one's practice Laurenson (1995) maintains that there needs to be a base from which one can reflect. He has modified a model from Perry (1970) which he calls a continuum of philosophical thought and applies it to the teaching of mathematics in terms of varying degrees of constructivism. At one end he places the positivists with their 'right versus wrong' approach while at the other, he places the relativists; that is, the constructivists with their emphasis on the process of mathematics. Laurenson writes that Perry conceptualised a framework along which a

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person moves from positivist to relativist beliefs as she gains teacher-experience, with the centre-position of the continuum representing a perspective of more than one right answer to a particular problem.

Ford (1994) reinforces this view that classroom experience can affect a teacher's espoused beliefs and can be a determinant in changes in the beliefs themselves. This two-way interaction between beliefs and practice is aptly described by Buzeika (1995) as a 'chicken or egg' relationship and she describes how classroom teachers found reflective practice a vehicle for re-organising their beliefs as a result of practice.

Grouws (1991) raises the issue of how pre-service teachers acquire new knowledge about teaching. Teaching is a complex phenomenon and learning to teach involves the construction of new knowledge. How teachers come to acquire this knowledge and how they connect it to previously held knowledge is an important aspect of research into the teaching of mathematics. Grouws (1991: 206) asks

- do teachers adopt new perspectives by abandoning one previously held, or do they initially entertain them simultaneously, using one or another depending on circumstances?
- how does the new knowledge teachers acquire affect their beliefs and conceptualizations?

Grouws (1991: 213) describes a constructivist model for teacher education where

> ... teachers as mature, thoughtful individuals can be directly presented with potentially useful information and that they can be counted on to assimilate and use only that information that fits with their past experience and knowledge.

Of interest to the current study is the question: how experience and the acquisition of knowledge affects a teacher's position on the belief continuum described by Laurenson (1995).

2.9 SUMMARY

The interlocking of issues raised within the review of the existing research is in keeping with the research model (Figure 2) by Koehler and Grouws (1992: 118) which links the numerous factors impacting on the classroom environment.
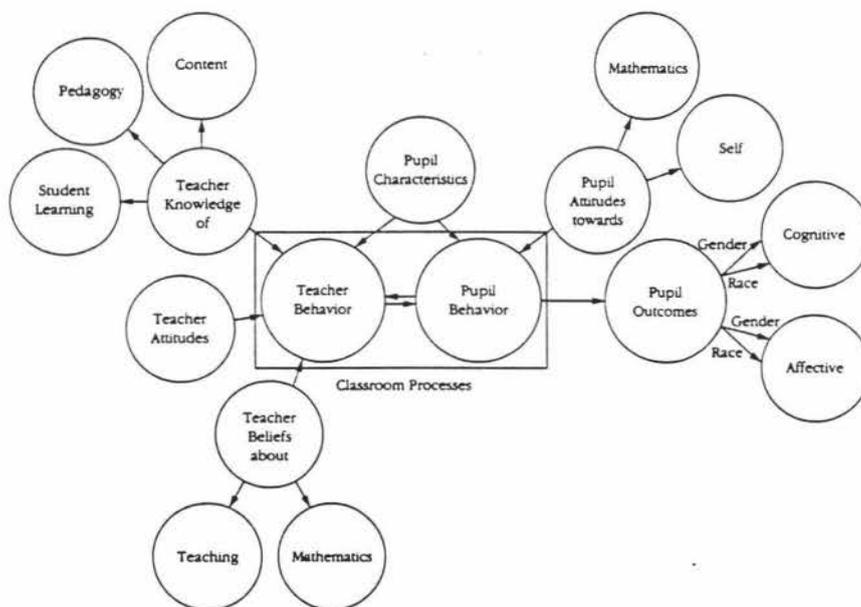
Figure 2   Factors impacting on classroom research

The current study uses a reflective model of research to explore whether the process of ongoing reflection on the issues raised in the literature, when embedded within the mathematics curriculum area, *is* enabling for teachers in their ability to implement their intentions: in particular, exploring the teachers' intentions in terms of overcoming the demands of the curriculum and of survival within their first institution.

CHAPTER 3

RESEARCH METHOD

Initial design

This study set out initially to explore the relationship between the beliefs and practices of beginning teachers in primary schools from the time they embarked on their first year of teaching through to the end of the first semester. The particular focus of their beliefs was on their intention to provide an equitable learning environment for the girls and the boys in their mathematics classrooms.

Koehler and Grouws (1992), as illustrated in Figure 2, highlight the complexity of the numerous variables affecting the everyday lives of teachers in the classroom, and as the study developed it became apparent that some of the most influential variables impacting on beginning teachers' effective practice were the socialisation into their schools, the processes by which they are able to utilise the effects of a constructivist-based pre-service education and the extent to which they are able to adjust or strengthen their beliefs through the provision of structured reflective opportunities. Together, these three influences: their espoused beliefs, their professional survival within the institution, and the expectations of a constructivist curriculum, formed the framework for the research, while the context was the teaching of mathematics, with particular focus on the effectiveness of the teachers to provide equitable access to the learning for both girls and boys.

A case study approach as in Sullivan and Leder (1992) enabled the researcher to interact with the participants and to use multiple means of data collection in order to combat the complex variables affecting the classroom environment. The data-collection framework used for the research

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was categorised into three components which were (1) influences on the teachers' beliefs and attitudes prior to their entry into pre-service teacher education; (2) effects on the teachers' belief framework during their time in pre-service education; and (3) constraints and opportunities within their teaching institutions which affected the implementation of their beliefs into practice.

3.1 APPROVAL

Permission to undertake the study was obtained from the Massey University Human Ethics Committee and copies of all information and consent forms used in the study were enclosed with the application for approval . Copies of these are included in Appendix 1. The Dean of Research and Learning at Auckland College of Education was consulted as the results would include reference to the teachers' experiences during their time at college. Information and consent forms were sent to the participants and to the Boards of Trustees of their schools; copies were sent to the school principals. On receipt of consent from both parties, information sheets were then distributed to the caregivers of children in the classes taught by the teachers.

3.2 DESCRIPTION OF THE PARTICIPANTS

The participants of the investigation were six first year teachers who had recently graduated from their pre-service education course. Of the ten teachers invited to participate in the study, three declined and one withdrew at a very early stage due to the recommendation of her tutor teacher. The teachers had been approached as a result of information that had arisen as part of their courses as pre-service teachers: towards the end of these pre-service courses the teachers had been asked to respond to statements which indicated their beliefs and attitudes to the provision of equitable opportunities in mathematics for both girls and boys.

The teachers represented a variety of backgrounds with respect to age and personal experiences, their own mathematical knowledge, confidence in both mathematics and the teaching of mathematics, and the teacher education programme completed. Due to circumstances beyond the control of this investigation, all the teachers were European and female: none of the men in the 300-level courses approached for initial interest were in their final year, hence were not teaching at the time of the study.

Questionnaires were administered to seek information on personal background and tracking of their mathematics education backgrounds, both before and during their time as pre-service teachers. The teachers graduated with a variety of teacher-education qualifications: three of the teachers followed a three year diploma programme, one a two-year diploma programme for graduates while two followed a four year combined degree/diploma programme. Details are provided in Appendix 2 along with a copy of the questionnaire that was used to elicit the personal information. Despite these differences, all teachers had completed a variety of optional mathematics education courses beyond the compulsory stage and to an advanced level, indicating a high measure of strength in the teaching of mathematics. These courses covered a range of specific issues: for example, teaching mathematics investigatively, awareness of culture and gender, and catering for the under-achiever. All the mathematics education courses were delivered within the belief framework of constructivism and this philosophy formed the base for the planning and implementation of the teachers' own classroom programmes.

All but one of the schools in which the teachers worked were within the city of Auckland while the sixth school was situated in a semi-rural/dormitory township. All the home communities were multi-ethnic and in four of the

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schools the population was predominantly non- European. Therefore, for the majority of the children taught by the participants, English was not their first language. The schools were well-resourced and the classrooms looked vibrant and exciting. Of the six classes taught by these teachers, only one class was outside the junior level; this teacher taught a standard three/four class.

Limitations of the sample are that it includes no male teachers and that it is set within a defined geographical area. Although the fact that all the teachers in the study graduated from the same college of education may be seen as a weakness of the study, it also adds strength to the findings as they represent the experiences of students participating in a variety of pre-service programmes across the college.

Although not self-selected, these six teachers were keen to participate in the study once given the opportunity. Their willingness to participate allowed the findings of the study to be reported as detailed descriptive data, relating closely to their unique experiences which took place within their individual natural settings. Pseudonyms have been used throughout to provide anonymity of the results.

3.3 THE PROCEDURE

This section contains a description of each stage of the study. The stages described refer to the initial meeting of the participants and the researcher, the keeping of the diaries, the initial individual interview and the two observations/reflective interviews. A timeline for the study is shown in Appendix 3.

Stage One

An initial meeting was arranged to include all the teachers participating in the study together with the researcher. At the time of the meeting the teachers had been teaching for one school term of a three-term year. The discussion focused on classroom issues in terms of both generic practice and gender specific practice in mathematics. The teachers shared their views on issues related to their strategies for the effective teaching of mathematics. Discussion on 'equal' or 'equitable' (Bennison, Wilkinson, Fennema, Masemann, & Peterson, 1984) resulted in the decision that their overall goal was to provide equitable access to mathematics learning for both girls and boys. Eight key issues were identified and the teachers agreed to keep a diary relating to these issues. The key issues, as listed in Appendix 4, formed the framework for the data collection of the study.

Stage Two

The teachers kept the reflective diary over five consecutive days of their mathematics programme. Due to the variation in routines between schools and to the flexibility of the schools' programmes it was not always possible for teachers to keep a diary for a standard calendar week; for example, some primary schools are now working to a six-day timetable and do not offer mathematics lessons, as such, every day of the week. The purpose of the diary-writing was two-fold: firstly, it gave each participant the opportunity to self-research (Mousley, 1992) initially on a wide range of issues allowing for a later focus on one particular aspect of mathematics teaching,; secondly, it was in the interests of this study to look for differences in teachers' reflection in both journalistic and interactive modes (Pultorak, 1993).

Stage Three

After submitting their diaries to the researcher for review, the teachers were interviewed. The interviews took place in their classrooms, after school, and were audiotaped, the main purpose being for the researcher to get a closer impression of the environment of the classroom, the school, and the working conditions. It was expected that the researcher would become a participant researcher at follow up meetings.

The specific intent of the first interview was to collect a data base on the background of the school and the teacher's class, as well as to explore the teachers' personal views relevant to the study as shown in Appendix 5. In order to examine the institutional influences which might affect a teacher's classroom climate, further questioning established the teacher's impressions of the environment to which she had been appointed, and of the attitudes and behaviours of the children in her class. Although the teachers had been informed of the structure of the study before consenting to participate, at this interview the opportunity to discuss details on an individual basis allowed each teacher to suggest alternative or additional directions. The teachers were asked to define their views of constructivism which would form the framework for their teaching of mathematics. Interactive reflection on the contents of the diary resulted in the identification of a goal on which to focus for the rest of the study. The purpose of this goal-setting was to plan strategies pertinent to a focus which might increase equity of access to mathematics learning for all children in the class. Issues specified by each teacher for individual focus are listed on Page 75.

Stage Four

Observations were planned according to the issues chosen by each teacher together with an observation grid based on constructivist criteria taken from

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the principles of Simon and Schifter (1991). A copy of this grid is included in Appendix 5. The observations took place during a mathematics session and the session was followed up by an interactive interview as shown in Appendix 5. First the teachers were asked to reflect on their teaching in terms of both their goal (Kuzmic, 1994) and then in relation to the constructivist framework. The grids then provided a base for discussion and further reflection. This reflection on their pedagogical practice resulted in refining goals and the planning of more specific strategies to further enhance access to learning for all children. Questions were asked to elicit the teachers' views on the relationship between a teacher's personal content knowledge of mathematics and her success in teaching mathematics in alignment with her constructivist beliefs.

To explore further their beliefs about the teaching of mathematics teachers were asked to rate themselves on a continuum with only the two ends labelled. The labels were 'traditionalist' and 'constructivist' (Laurenson, 1995) and this gave teachers the opportunity to identify the level of constructivism within which they perceived their practice to be embedded. A second continuum, again labelled only at the two ends, was used to measure the teachers' perceptions of their own level of mathematics. Specific measurement markings were avoided , and only the words 'low' and 'high' used, on the continuum in order to open up the relationship between competence and confidence. Both the continuums served as a base for discussion during the interviews as the teachers were asked to qualify and support their decisions with further statements. Examples of the continuums are included in Appendix 5.

As a result of her reflections each teacher then refined her goal in order to intensify the focus for the next observed session.

Stage Five

The final interview, again following a classroom observation, allowed the teachers to reflect on the value of structured reflective practice in achieving a goal (Kuzmic, 1994). The teachers were then asked to identify constraints and opportunities (Clark & Peterson, 1986) which may have affected their socialisation into the institution and to specify strategies for resisting any constraints (Lacey, 1977; Goodman, 1988; Zeichner & Tabachnick, 1988,). Questions were then asked to enable the researcher to categorise the teachers' perceived influences, on both beliefs and classroom practice, of family and school backgrounds, pre-service teacher education , and of current teaching experiences (Sullivan & Leder, 1992; Rust, 1994).

Observations and interviews

The observations within the classrooms served a dual purpose: firstly they extended the researcher's knowledge of the classroom environment and of the children's attitudes and behaviour within mathematics time; secondly they allowed the researcher to observe the teacher with respect to both her defined goal and her constructivist intentions.

All the interviews were semi-structured, that is a base of questions was prepared, to act as a foundation for the interview. However, these were adapted according to the responses of each participant and as is legitimate in a qualitative style of inquiry the researcher deliberately interacted in a personal way with each individual in the study (Borg, Gall, & Gall, 1993). A sample base of questions for each interview is included in Appendix 5.

As the study progressed, the teachers each acknowledged its value as professional development for themselves and they made use of the

procedure, as a support mechanism, for focusing on issues within their mathematics teaching.

3.4 DATA ANALYSIS

All data, including the transcripts of the interviews, was analysed for patterns and trends against a theoretical background of existing literature. Although it was foreseen that the naturalistic setting for each case study could lead to a reduction in validity in terms of generalisability of the findings, it was anticipated that the "thickness" of these findings (Borg, Gall, & Gall, 1993: 101), together with the variety of data explored, would enhance the reliability of the results. The final stage of the study was to add to the reliability of the results by confirming with the participants that all data included in the report was a true and accurate record of their responses.

CHAPTER 4

RESULTS

The results are presented in relation to both the literature and to the evolvement of the study. They take the form of teacher contributions and responses as they reflected within the structure of the study. Information collected about the teachers at the beginning of the study has been included in the form of an individual profile of each teacher. These profiles describe the mathematical experiences of each teacher from the time of her own schooling through to her beliefs about mathematics teaching at the embarkation point of this research and are included in Appendix 6. The results, as well as being examined in detail in Chapter 5, are analysed briefly at the end of each section.

4.1 BELIEFS ABOUT CONSTRUCTIVISM

> **How did the teachers perceive their ability to put their constructivist beliefs into practice?**

The teachers shared the common belief that constructivism in the classroom shifted the focus from the teacher to the learner. It was evident that the definition most commonly remembered from study during pre-service education was 'children constructing their own knowledge' and it was believed that this enabled a child to work at her own level, while participating in the common task.

Emily: *From what I've seen and heard, mainly from what I've seen in my classroom, some children just aren't ready to learn some things. So to me ... the constructivist idea is that if you give them equipment to*

work with, if you give them an idea to work with ... they can go with it.

Tracey: *As a constructivist I believe that children need to construct their own knowledge ... and play with the concept and develop it.*

In terms of mathematics the teachers believed that learning based on constructivist principles resulted in an increased richness of the learning experience when children were allowed freedom to create solutions to problems using their own processes, to question for themselves and to share their ideas with both other children and with the teacher.

Julie: *I like the idea of letting them play with the equipment, using the equipment more creatively, because then they get more from it. Yes, that's with their developmental activities ... that's constructivism.*

Claire: *... so they could carry it out in their own way and use their own ideas.*

Rachel: *... the children constructing their own knowledge through investigations and asking questions. I have brought in problem solving and the children have found it quite difficult, some of them latched on quickly, but they found it difficult, the idea that there might be more than one way of doing it, or sometimes even more than one answer.*

Emily: *It (constructivism) gives them a chance to demonstrate what they know, or to experiment.*

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The importance of 'maths talk', children talking about their mathematics, was identified as an important aspect of mathematics learning, and support for the paradigm of social constructivism was evident.

Tracey: *Constructivism, that's actually my focus ... but before I read about it I didn't actually consider it as part of my planning or evaluating but when I thought about it ... maybe that's not quite such a bad thing because they are watching, talking, doing, listening all the time.*

Kylie: *In the teaching of maths, ... well I believe that children construct their own interpretation of the world and I think for each child it's unique and different. But I don't think they do that on their own. I think they do it in a social setting and I think they do it in partnership with other children, adults, you know, whoever's there.*

The self-ratings on the belief continuum designed by Laurenson (1995) where the teachers identified themselves as traditionalists or constructivists (see Appendix 5) added further information to the study. This was presented to the teachers after they had stated their own definitions of constructivism. The teachers' self-ratings, on a 1 - 10 scale, 1 for traditionalist and 10 for constructivist, are shown in Table 1.

It seems that the two main justifications for leaning away from constructivist principles were that teachers would not necessarily be able to identify children's learning and understanding unless assessed in a traditional manner and that, despite their current beliefs, teachers are influenced by their own school experiences.

Table 1

Belief ratings on constructivism and practice

Teacher	Rating	Justification
Emily	8	*... there's an element of traditionalist in me because I do think they need to know some things.*
Kylie	5 - 8	*I'm probably running backwards and forwards between these because of the way I'm constructed myself, ... by my own experience ... I guess there's part of me that's still there whether I like it or not ... I don't fight it but when it comes out I say "Oops, hello!'*
Julie	7	*It's all very well, what we heard at college, but out here ... well ... you've really got to get right in and encourage them to do anything.*
Tracey	8	*I wouldn't put myself right at the end because I don't have the trust that the children would get around the concept and cover everything I want them to cover*
Claire	7	*I think the children need to construct their own knowledge to get understanding of the mathematical concepts and then once they've got that I'd probably use a bit of a traditional thing later as an after thing ..... but I don't do that often.*
Rachel	6	*At college I've seen the different activities and resources which influence you in the constructivist way but the traditional is still a big influence because of the way I was taught ... that sort of affects my thinking ... and it does pull back.*

4.2 PROVISION OF TASKS

> Were the teachers able to meet the challenges of providing appropriate tasks to teach mathematics according to constructivist beliefs?

All the teachers expressed a desire to provide tasks which encouraged the children to think and plan for themselves. This was apparent at all levels including the youngest junior classes. Situations ranged from a very open-ended statistical experience which focused on the children's own design for collecting, recording and displaying data to more structured shared activities which allowed individual development of processes or strategies to achieve success. The teachers were able to explain and justify their reasons for planning these activities.

Kylie: *Well the topic is statistics and we've been looking at different things, we've had line-ups, ... we've been doing different things. With children of this age, it's very difficult for them to get the concept of comparison. All they are interested in is the 'most' or 'who's winning'. Tomorrow I'm going to get some of the older children to go round the classrooms and find out some information. I really don't want them to be recorded formally. I just want them to get the idea of asking questions and writing something down and I don't care what they come back with. They can work out their own way of doing it, then come back and share with the class whatever they come up with.*

Julie: *I posed a question this time. I said OK we're going to re-arrange the classroom and we've got no rulers - well they didn't have any rulers. They said OK so I asked 'How are we going to measure it? What can*

we find out about it? How are we going to arrange it? Can I put the piano over there? and they said no because it's too small, right. That was a starter for them and they went through ... using their own strategies which was constructing their own learning ...

The provision of in-depth tasks was also valued for the opportunities it gave the teachers to listen to the children, to analyse the discourse and to interact themselves with the children to develop their understanding of the concepts from their own ideas and directions.

Rachel: *I planned my questions but I didn't really sort of plan specifically what questions I was going to ask ... maybe to make them a bit more open ended instead of telling the children to look for this or look for that. Leaving it more open like "What can you find out if you ... ?" You don't sort of get the chance to think of those things you know when you are in there doing it yourself and even if you were thinking of them, you can still misconceive what they are doing or thinking.*

Tracey: *I believe whether children can do it or not I try not to teach it too much but I try and let them play with something and see if they can figure it out themselves. I try and let them play and just sort of see where they at and then try. I try to let them play and get that interaction with the environment without too much direction from me. To create some sort of knowledge about what they are playing with. I like roaming around just asking them what they were doing and how they made things happen.*

Claire: *Well, I wanted to speak to each individual and I think the way I set it up with smaller groups it was really good to be able to actually go round. You could actually see what each child was doing so I think probably in just under an hour's lesson, I think I probably spoke to each child twice, three times probably. Well, you've got to communicate with individuals haven't you, you know, because otherwise you wouldn't actually see. I mean if you just take a look you wouldn't see that, you would have just thought "Oh no, he's got it wrong".*

Many of the teachers commented on the conflict between constructivism and their perceived cultural expectations of some the communities. In the case of children who had received no pre-school experiences outside the home together with family expectations that teacher knowledge should never be questioned, legitimising open-ended questioning and investigative tasks was likely to cause embarrassment for some children.

Julie: *... their parents have been brought up in such a manner that they say school is school, and the children are not going to come in and tell the teacher what to do. So constructivism - well the children constructing their own ideas about things, being allowed to construct their own ideas, they're so used to being directed in everything that they do ... it's difficult.*

Emily: *They (the children) are very enthusiastic about doing things for you. They love doing things for you, doing things with you. They really love knowing something, they love being right and it's always tough starting off one of the topics which they don't know very much about*

... they like to be safe. They don't like to take a risk. I think this reflects their home backgrounds.

Rachel: *I find the children in my class are scared to offer. They don't ask many questions and they are always worried about getting things right. That is a really big thing you know, they want to get it right. I have never been challenged about anything that I have said ... the school culture maybe, or their own culture ... and then maybe they haven't been asked to challenge. When I had my parent interviews, every parent asked me how their child behaved in the classroom and two mentioned more than once the word respect for the teacher.*

Despite the intention to provide challenging situations for the children, teachers views now focused more on the involvement and the attitudes of the children themselves within a constructivist setting. However, it was evident that whenever possible, all teachers planned their children's mathematics experiences to include problem-solving. All children were encouraged to explore for themselves and some were even expected to negotiate their understanding of the processes involved.

4.3 ASSESSMENT IN A CONSTRUCTIVIST ENVIRONMENT

> **To what extent are the teachers able to devise and use methods of assessment which address the broader issues of constructivist learning?**

A common situation for the teachers was the expectation that accountability for their children's learning should be reflected through the assessment

procedures used by their school. These procedures were usually in the form of checklists, either resource-based or curriculum-based. Two concerns were raised about the checklisting of children's performance: the first concern was the anxiety and pressure within the classroom for a teacher who was expected to be rigorously involved in checking off what seemed generally small and isolated tasks; the second concern was about the skills-based nature of the assessment tasks themselves. The extent to which the assessment tasks currently in use in the classroom reflect the broader aspects of constructivist teaching and learning were thought to be unsatisfactory for these teachers. Resources used as a base for assessment of the children's learning tended to have been produced prior to the current focus on constructivism.

Tracey: *I start that (my assessment) tomorrow and she'll (my support teacher) have a group and I'll have a group. They're ability-based according to what they're up to and we do it based on these things. It says use the words short, long, shorter than, shortest, ... so I've got to be quite specific. These are what I see as behaviourist objectives. For me to get these from the children 'on the day' is just ... it's like ... "Do it, do it on the spot now please. I can't wait for it to come when you're ready, you've got to do it now." .... I find that very frustrating.*

Kylie: *... the assessment procedures put a constraint on what I do. I think you do have to assess accurately but I would like to do more observational assessments with written comments. The assessment is getting in the way and what I'm saying is that, because there are so many things to look for, I don't think for one minute that it's logical to write down " ... at algebra level one ...". I think if I did it for maybe four or five weeks, 1, 2, 3, 4, 5, I mean if I've ticked somebody*

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here or put a dot there, well that would give me a better idea. But it feels frustrating and what feels frustrating is not quite being able to ... to say what you know about them. I mean you're always asking yourself the question "Why do I feel this way? Why does this not feel good to me?" But it is getting in the way although the achievement objectives aren't necessarily the problem. They are O.K. as achievement objectives. No, it's just being expected to record more and more. I find myself feeling guilty when children aren't meeting what is expected.

Emily: *We have very much a checklist type arrangement. We have individual files for each child and all those objectives are from the curriculum and they get marked off when the child has just reached that objective. So on our checklist I have to build a lot of information before I actually get to tick off the curriculum objective because there's so much more to it than just that big objective. I know what the people who have been working with me have been doing and I could put their little tick or their little cross or whatever on my sheet. Then I'll be looking around the room and walking past individuals and getting an impression of whether they're actually doing that or not.*

Strategies the teachers used to overcome their frustrations while still fulfilling the requirements of the school system were varied. One strategy was the setting of their own long term objective, using the curriculum, which allowed for the addressing of some of the broader issues of constructivist learning. This curriculum objective provided opportunity to assess the thinking and the problem-solving skills of the children but was planned to encompass the smaller objectives set down by the school. Another strategy

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was the setting of a variety of open-ended activities, often set out as 'stations' which allowed the teacher opportunity to assess the children's choices as well as to observe and record wider aspects of the mathematics processes such as the development of an idea or an argument.

Rachel: *This school has some of those topic-based resources and they thought they'd be good. I sort of thought it was a contradiction because we've got the curriculum and that's what I've worked from at college and that's got all your learning outcomes or whatever you plan for. And the school's got a lot of resources anyway that you can go to, to fit in with those things. I found having to find all those resources and the activities was a nightmare and there were so many activities just for one little thing. I have been happy just to find the resources myself when I need them or just go from what activities I knew and I thought it was really ... oh I don't know, I just didn't like it. So when they said "You can do whatever topic you like this term", I thought "Well, if I'm free to choose a topic, I'll just let go of topic- based altogether." I mean, I feel more confident just using the curriculum and the resources available so that's what I've done.*

Julie: *In a maths classroom it means that if the language is not there you don't know ... if they're thinking in Tongan or whatever is their own language. I wish I knew if they were thinking in Tongan and then having difficulty putting it into English or ... it would be OK if they were thinking in Tongan ... and I don't know how to find that out. I try to use more open-ended activities so that I can watch more. It's all very well asking the standard questions but if English is not spoken in the home and you know they know the shapes ... great ...*

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they can see the shapes but they don't know the words for them ... but
perhaps you can watch how they use them.

Kylie: *I think the temptation at this level is to move children into*
formalities before letting them explore the ideas and the concepts.
That's what I wanted to do. I don't get much time because we sort of
plough through our topics fairly quickly. We have a topic-based
programme and I've tried to use it but run away because that's not
the way I would like to teach maths. My children, when I watch
them, they are doing maths just about all day and in some form or
another because that's what they are interested in. They talk about
what they got for lunch, they make comparisons and do all sorts of
things you know informally. There has to be a structure to it and
we've got to have objectives that have to be met but ... I don't think
that the way the maths of the NZ curriculum was conceived intended
these objectives or learning outcomes to be flagged across the
classroom the way they are, without considering the needs and
interests of the children.

While many of the teachers mentioned their liaison with the parents over
their classroom mathematics programmes, Claire, in particular, commented
on how she confronted the parents over her conflict with the school's
expectation that the children's maths books should give the parents an
understanding of their child's mathematical knowledge. By explaining to the
parents that there were other tools for assessing children's mathematics,
besides written bookwork, she involved the parents in the assessment issue.

Claire: *When I went to them (the children) individually I got them to look*
back and have a look and see if there was a pattern in there and

whether they could estimate the next one and things like that. We talked about what they had found and how things went wrong sometimes and what you could do about it. They tell me so much about what they are trying to do ... It's really hard though ... my children have hardly got anything in their maths books because I haven't done that sort of formal setting out, you know. I just haven't done that sort of thing. I've done a lot on big paper like today, but I mean if you did that in a maths book it would probably look useless to some parents ... they'd probably wonder "what the heck ... ?". So I've talked to each individual parent and said "Look, we don't really do lots in maths in our maths books you know, so please don't make that a judgement of our learning. It doesn't mean they haven't learnt anything all year just because they haven't got much in their books." I know they have covered so much but looking from outside, well ... I can understand how they might feel.

All the teachers commented that their choice of alternative assessment procedures allowed them more flexible time within the classroom to observe and to ask questions of the children. However their frustrations with the assessment procedures expected of them highlighted for them the need for resources to support the curriculum. Otherwise their intention of providing rich mathematics experiences based on constructivist principles has the potential to be negated by behaviourist assessment objectives.

4.4 EQUITY IN THE MATHEMATICS CLASSROOM

> **How do the teachers provide equitable access to mathematics learning for girls within a constructivist setting?**

Teachers reported that they needed to use definite planned strategies to overcome some of the inequities of the mathematics classroom. Barriers to learning most often identified were the extrovert behaviour manifested by boys which demanded immediate attention and the more overt participation of boys in the learning situations, as opposed to the usually more passive role taken by girls.

Kylie: *I sometimes wonder, like all teachers ... you know, boys in the classroom always tend to demand a lot of your attention. How much and what kind of interactions I'm having with the girls in terms of their maths.*

Claire: *All you read and all the talk you do at College about spending more time with boys, even though you think "I don't want to do that", it ends up happening because of the behaviour thing. That's what I find very, very frustrating.*

Rachel: *I've noticed that the boys will move onto their own made up games, you know ... they tend to do that more than the girls.*

Julie: *I know when I say, as I do once a week, girls only and the girls go on the Lego it's all everywhere just like the boys but after ten minutes*

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they've had enough. Meanwhile the boys will just sit there, and sit there and sit there.

Strategies commonly used to break down these barriers included attention to the quality of interactions between teacher and children, encouragement of children to listen to each other and using a variety of arrangements of children into working groups.

Kylie: *Now what I'm trying to do with those boys is deal with them as quickly as I possibly can and get them out of my hair. I don't know whether I do but what I try to do is not ignore the boys but diminish the effect of what ... they are creating. I try not to over-react even though sometimes I want to and I feel I want to. I also try very, very hard to keep an eye on the girls and I try hard to address the girls. I try hard to pull the girls in and confront them. I try to do a lot of confronting. I try very hard all day to try to confront girls but I try harder at Maths.*

Rachel: *I ask somebody to repeat what someone else has said or just focus in on them ... and we do lots of sharing in pairs and small groups ... and that helps a lot too.*

Claire: *Well, I tried to improve the involvement ... each task was a set task but they could carry it out in their own way and using their own ideas. I did try to mix the groups ... I just chose them off the top of my head, there, when I was doing it. I mean ... they explored everything ... that's why I put out so many different things ... and I could go round and find out exactly what they actually got out of the lesson. I wanted to them to work in pairs in some of those things, like the one with the pegs. I wanted them to communicate with the*

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gear and with each other. I think they did actually show each other a lot of what they were doing like "I've done this ...", but I did want them to work in pairs in some of those things so that they can actually discuss with each other what they were doing. If we'd had eight, or something like that, in a group you probably would have very little interaction.

Kylie: *I do a lot of social grouping in maths. I mean I let them choose quite often who they work with. Then sometimes I push them in other directions with other people, sometimes I buddy them, sometimes I let them buddy themselves. Looking at the girls and boys in this class, I always think of what they know. I think of them in terms of their whole life. I let them talk a lot and to different people.*

Attention was frequently given to the context of the learning experience. As believers in constructivism these teachers were aware that the mathematics needed to be presented within contexts which were meaningful to the children. Concerns were expressed, however, at the need to recognise differences in the values and experiences of their girls and boys. Some teachers expressed the desire to focus on the individual, rather than on gender, as the issue, but were surprised at the frequency with which contexts validating the learning did in fact relate to a gender-specific world.

Tracey: *The talking could be just what you see on TV last night and they (girls and boys) talk about different things of course. They watch different things, they have different interests ... girls talk about things that happen in school time, interaction. Whose friend ... and about social happenings at lunch time and the boys talk more about TV and Batman and X men and things.*

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Julie: *I think the girls got more involved because of the dough. Once they had dough it became a social thing for the girls. You know they were talking and they were getting more into it than boys. The boys weren't too bad. In a way I would have expected the boys to be a lot more rowdier but they were actually not. Maybe because the girls were getting a lot more vocal.*

Emily: *Well we might often get free choice in maths each day, about maybe ten minutes, to use whatever equipment they like. There's the beads and threads, the Mobilo, the big wooden blocks ... Yes, when I was writing reports I was making comments, we write quite general reports and something that I wanted to put on was some things that the children actually enjoyed. So I got busy watching and almost without exception everybody in the room tried for the Mobilo. Now the boys go to the Mobilo fast and all going well the boys get the Mobilo and girls get what I suspected ... anything but. So after that I kept saying 'Boys can't use the Mobilo, it's girls today' but I've stopped doing that again. Well I haven't deliberately dropped it. No I haven't, I must do it again because the girls faces light up and they made interesting things. I gave the boys something else like the rods or ... we've got corks. I've got a whole pile of corks and ice block sticks and they still do things out of those so they are not completely dependent on the Mobilo. Interesting, the girls don't tend to build things out of the corks and stuff they make patterns. They often do threading and things ...*

Kylie: *Girls culture, I mean I'm aware of it and I keep trying to do things that interest them. You know takeaway food is a fairly neutral one at*

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*this age. Tomorrow I'm sending one group off to do some data
collecting in their own way which ever way they want to and I'm also
going to do some smaller statistics activities with the other children
on favourite TV programmes, favourite toys, things like that. Then
we will get the barbie dolls and things ... I mean ... I hate barbie dolls
but for these girls that's their world. You know maybe I should create
some topics on measuring barbie dolls or making barbie dolls. My
girls have barbie dolls and I'll try, but I hate them all the same.*

Overall, the classrooms used in the project contained a very high proportion
of Pacific Islands children (see Appendix 6) and some of the teachers felt that
in terms of learning behaviours gender took second place to culture. It was
thought that the traditional home influence, and its cultural expectations,
was responsible for the nurturing attitudes and behaviours of many of the
girls, particularly in a multi-level classroom situation. Teachers' awareness
of the issue saw them initiating strategies to lessen the detraction from girls'
own work.

Tracey: *To make them more independent I think, this is my goal. Trying to
get into them that some have a habit of telling everyone else what to
do and obviously often doing the wrong things themselves because
they're busy telling everyone else "Oh you should be doing this, you
should be doing that". They tend to be girls, some girls, some boys,
older ones in the class who feel that they are older and they have this
responsibility to look after the young ones, which is fabulous. But
they often don't stop to think and they're often busy telling everyone
else what to do, and not thinking of what they should be doing. In
my class my girls are older than my boys and that gives that
mothering-type atmosphere in the classroom, which is not me. I'm*

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not a mothering-type person so they jump into this mothering role and I'm trying to get them to be more independent, the little ones and the big ones, just to worry about themselves. I just praise. My whole philosophy on behaviour management in general, which I try to follow is to just praise what I like and what I see as good and what will get them where they want to go and hopefully ignore what I don't like. I'll see someone who is doing something that is for themselves and I'll say "I really like the way you're looking after yourself and you're worrying about what you are doing". I try and come around it that way. I'm making a value judgement on them if I say "don't mother ...", and I don't want to do that.

Emily: *A lot of them have got very definite personalities and I've got ... especially some girls ... who have got quite dominant. They're quite positive people who want to know what to do, who want to know how to do this whereas a lot of my boys are bit silly. The girls will actually be with me when I'm talking, when I'm having a discussion whereas I've probably lost half of the boys. They help the boys a lot but I wonder what would happen if I grouped them into girls and boys?*

Teachers admitted they had not been with their classes long enough, nor were they experienced enough teachers, to establish whether the identified trends were gender-related or due to individual personalities. Nevertheless they recognised, within their classrooms, behaviours which were familiar to them from previous study.

Rachel: *Now Jess ... she won't question you, if she is not sure of something she will just go off and do it wrong. She will just do what she thinks*

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instead of saying hey I am not sure about this, can you tell me again
... but Steven ... he is the sort of person that bursts out, he likes to talk
to the teacher and so ... I can feel that pull towards him every time he
sort of say "Hey look I've done this" or "I can't do that" or "I've
finished". Whereas the girls tend to sit down and they are a bit ... I
don't know ... whether they are more thorough or they just take a bit
longer to think about what they have to do. Then Apii ... she didn't
really (join in) ... she sat there for a quite a long time knowing that
you could do it while Tama, he was going "Look I can't do this, this
is really hard" and she knew all the time. She knew that and she
said "Look I've got that one too". But she does tend to sit back
because she doesn't like to give all the answers ... and she does sit
back but I don't know whether that's a boy/girl thing or just those
characters.

Julie: *Maria is very capable, likes to work on her own but she likes to help*
people as well. She doesn't go off task very easily, always listens
first, doesn't jump in, she doesn't really ask questions much. But
Tanio, now he's Tongan. He's my interpreter. Very good. Very keen
to try things, likes working with the hands-on equipment. Then
Jonno ... he's very capable. Calls out a lot. Likes a lot of attention.
Mathematically thinking. And Gay ... she's very, very quiet but very
capable, answers the question if you ask her. If you ask her a
question she'll answer you, if you ask it generally, she'll sort of sit
back and let the others answer but you know she knows the answer.
Well I feel that I know that she is OK. I usually know when she's
confused because she'll sit there and you can see her nutting it out,
thinks about what she's doing, slow, precise, she doesn't rush into it.
Gay really sits there and thinks "Am I doing it right?".

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A substantial proportion of research into differences in the attitudes of girls and boys focuses on post-primary levels of education (Morton, Pemberton, Reilly, B. J., Reilly, I. L., & Lee, 1988; Turner, 1994; Blithe & Clark, 1995). it It seems evident, however, that the behaviour of some boys, even in primary classrooms, can affect not only the performance, but also the attitude, within mathematics for some girls. These teachers found that girls' access to the learning can be improved by their efforts to ensure a non-threatening mathematics learning environment, even for very young children.

4.5 PRE-SERVICE INFLUENCES

> **What influences from their pre-service teacher education were thought to have been effective on the classroom behaviour of the teachers?**

Influences from their pre-service education programme most commonly reported by the teachers were related to curriculum, organisational and content knowledge issues.

Curriculum issues ranged from familiarity with the curriculum document and finding one's way around it, to the provision of a sound philosophical base.

Claire: *I think I actually use the syllabus, which you notice a lot of people don't use. I actually pull that out first which is great. I look in the school scheme, yes we're supposed to be doing this, ... but I pull that out first, and that's really good whereas if you didn't have that you'd swim. You'd swim through all the books that are in the cupboard there and stuff that gets handed at you.*

Emily: *Like how to work the curriculum and what to 'do' with these resources ... anybody can (teach) if they know a few basics but to teach well you've got to know how to work the curriculum. To teach well you have to know a lot more about how people work, I don't know about what ... about everything!*

Tracey: *My philosophy. Just being very sure of my philosophy, even if I can't use it, knowing exactly what I believe and how children learn. Being able to evaluate myself and other people based around my philosophy. Well, Maths courses were what did it. It was Maths courses that I got my strongest philosophy from ...*

Acknowledgement of the grounding received, within the mathematics education courses, for addressing specific aspects of mathematics teaching identified, in particular, the importance of listening to children and of creating a rich mathematics environment through questioning.

Rachel: *... basically just listening to children, seeing where they are at. You know, you don't sort of guess what they are doing. That was a bit of a focus of the underachievers' paper, you really have to probe to find out where they are because "I might fool you with something that I do" so I think that sort of leads to everything really that you do. You know, listen to the kids and really look at what they are doing.*

Julie: *Being able to change things when the children come from a different direction. Using things that they know about as a maths starter. Using what the children are interested in, taking up on a point about*

that. Things like that, being able to cope with such a range of ability. What they can and can't do.

Tracey: *In terms of actual strategies, the practicalities of teaching mathematics, being able to live with a child and figure out what mathematics they are using. A lot of those assignments at college which were about understanding a child's mathematics and what that child is doing to solve this problem. Well, I really enjoyed those because it was really interesting seeing the little child's mind working and where they were going and that's the most valuable skill I think. I think teaching mathematics is just trying to follow what they are doing in their head and going with it and understanding what they are doing rather than imposing what you're doing. That's the skill that I learned and other strategies like questioning and opening up a task ... yes, in questioning and widening it out.*

Appreciation of the opportunity to develop their own personal knowledge in both mathematics and mathematics education, including opportunities for discussion of issues and recognition of the importance of the 'hands-on' nature of the courses, was reported.

Kylie: *Learning that constructivism applied also to maths and once I learned that and once I internalised that then I wasn't frightened of it anymore. Because I realised that it could be built in the same way that all other knowledge can be built, through experience and by doing, and by relating to other people ... that's what eventually gave me the confidence to actually enjoy Maths because ... I didn't have to have all the answers. Somewhere from that first year and that second year paper I made that connection. Maybe it hadn't been*

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quite internalised but I had made the connection and somewhere in there the change happened. I think realising that I didn't have to stand up there and be an expert, that it actually matched up with what I believed about learning generally.

Rachel: *I found the practical activities where you actually sat down and went through something yourself is the thing that I remember and those are the things that I have used in my classroom.*

Emily: *There was a lot of doing in the maths courses.*

On reflection the teachers felt that many components of their pre-service teacher education programme were of use to them in the classroom. In addition to this, four of the teachers in the study, the older ones, reported that one factor contributing towards the positive influence of their teacher education on their classroom behaviour was their personal life experience before entering college. It was felt that their own backgrounds had, themselves, influenced what they 'took out of the college courses'.

Tracey: *It was helpful going to college as an adult I thought, being quite a strong person at college, being quite a thoughtful person and already having the study skill of being able to critique. It took me a long time to decide what my beliefs were because I ... there was so much ... and what I believe ... it's quite set now.*

Kylie: *I came to college, you know, with no qualifications. I had done a lot of things before and there were some things that helped me turn the keys for myself.*

Emily: *The thing that I found most important at college, and I think this may have been because I was slightly older going through, was that if you had a tutor who did this, everybody afterwards would then say "oh, they just rabbited on about nothing blah blah ...." But they were saying "when I was in my classroom, I did this, and this and this..." and I thought, "Oh, right, I'll remember that one then". Or they said, "I did this one day and this terrible thing happened, don't ever do it ..." and people missed that and often we were told stories that were not directly related to what was going on but were vitally important.*

Claire: *I got a lot out of (college) definitely learning heaps and heaps but I think I still kept my own ideals. It's probably maturity as well, isn't it ... I think that's what comes through all the time is that you keep your own ideals even your own ideas about learning ... maybe they adjust but they don't change, you know you adjust them to fit in.*

Two of the teachers, the younger ones, with less personal life experience other than their own schooling, seemed to have expectations that a pre-service teacher education would provide practical and real strategies for day-to-day classroom life. Organisational details, mostly referring to group management, were foremost in their minds.

Julie: *I think it takes me a long time to settle into an environment ... it's not until halfway through a year that I ... just settle down. I was more confident working in some subjects than others. College provided me with practice in taking more than one group at once.*

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Rachel: *Some of the courses are a bit slack at college. I floundered for a while on some of my classroom programmes. I found at college that in some of my subject areas there were all different things but not enough on your classroom programme.*

It is evident that prior experiences can affect the way in which a pre-service teacher education programme impacts on an individual. This in turn impacts on the ways in which pre-service experiences influence classroom behaviour in the first year of teaching.

4.6 SOCIALISATION INTO THE INSTITUTION

> **Were there levels of socialisation for the teachers depending on the influences within each institution?**

During the interviews each teacher was asked to reflect on their mathematics teaching in terms of the school's expectations. Despite their short time in the school the reflective responses of the teachers indicated a high level of practice relative to their intentions. Using the social strategy model (Goodman, 1988), as described in Chapter 2, for defining the extent to which a teacher is socialised into a school's environment a summary of teachers' reflections on their practice from, the current study, is shown in Table 2. For detailed descriptions of these levels of compliance see Chapter 2.

The lack of responses in the overt compliance category indicate that the practices of these teachers were beyond the level of overt compliance. The spread across the categories of this model suggests that although these

Table 2

Teachers' reflections on the their mathematics practice

	Overt compliance	Critical compliance	Accommodative resistance	Resistant alteration	Transformative action
Tracey	–	•checklisting[1]	•delivery style[1]	•children's context[1]	•openstarter task[1]
Julie	–	•teaching style[2]	•noise level[2] •integrated activity[3]	•using equipment[2]	•girls-only days[2]
Rachel	–	•daily tasks[3]	•management[4]	•resources[3] •problem solving[4]	•maths time[3] •pupils out of class[4] •use of curriculum[5]
Kylie	–	•checklisting[4]	•achievement objectives[5] •maths time[6]	•maths talk[5]	•children's thinking[6]
Emily	–	•checklisting[5]	•topic based maths[7]	•free time[6]	•learning outcomes[7]
Claire	–	•delivery style[6]	•maths books[8]	•meaningful context[7]	•mixed-ability[8] •use of curriculum[9]

The numbers refer to the full statements within each category, as included in Appendix 7.

beginning teachers did feel some need to fit into their institutions they were, nevertheless, able to resist institutional expectations which they considered unsatisfactory for their children's mathematical experiences. Detailed descriptions of these responses are included in Appendix 7, referenced, by number, within each of the above categories.

The teacher's opinions about their experiences, categorised as in the Goodman (1988) model, illustrates *their* perceptions of *their* socialisation into *their* respective institutions. The analysis of these opinions indicates that the teachers in this study appeared to already be thinkers, to be experienced in reflective practice and to have the confidence to be able to take reflection-driven action.

4.7 THE REFLECTIVE MODEL

> **How were the teachers able to use the opportunity of reflective practice to set their own goals for providing equitable access to the mathematics learning within the belief framework of constructivism?**

Two essentials in the achievement of a goal are the capacity for reflection and then the ability to take action as a result of this reflection. The process of reflective practice used in this study served as a means of investigating how, within their classroom environment, the process could support teachers in increasing their knowledge and maybe changing their practice. Continued reflection enabled the teachers to modify their own behaviour within their classrooms if they thought it necessary. The opportunities for reflection, as

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described in Chapter 3, allowed the teachers to make reflective comment of both a written and oral nature.

Written reflection

Comments in the reflective diaries were in response to issues agreed upon by the teachers in the initial group discussion These resulting issues form a basis on which the findings from the study are reported and are shown in Appendix 4.

Oral reflection

Comments from the interactive interviews were in response to the self-evaluations and researcher-observations of the teacher behaviour. From the issues reported on in the diaries, each teacher had identified one key aspect that they thought important in the provision of equitable access to the mathematics learning for girls and boys. The key aspects chosen by the individual teachers remained focused within the overall constructivist framework of this study. The specific issues investigated were:

Rachel	my interactions within the teaching group
Claire	the children's dialogue/interaction with each other
Kylie	the quality of interaction between self and children
Emily	the learning behaviour of the independent workers
Tracey	the learning styles of the children
Julie	the learning behaviour of the independent group

In exploring how reflective practice supported this study, the findings have been analysed from two specific perspectives. Firstly, the results indicate the different ways in which reflection can support teachers' behaviour can depend on whether the reflection is through written or oral comment. Secondly, the findings from this study report on ways in which the process of

interactive interviews helped the teachers set goals to assist them in modifying their behaviour with respect to the particular focus issue.

Written and oral components of reflective practice

The teachers' personal reflections have been categorised according to the framework developed by Van Manen (1977), and adapted by Pultorak (1993), as described in Chapter 2. Some examples of reflective comments which appeared as part of the current study are given in Table 3, illustrating both written and oral reflection.

The numbers of reflective responses are shown, according, to type in Table 4 and indicate that even in the first year of teaching, given a reflective structure within which to work, these teachers were able to reflect in almost equal depth across all categories in this model. Furthermore, comparison of individual teachers indicates a variation between the number of reflective responses given by them and this is to be expected when using a process of semi-structured interviewing.

The differentiation between the types of reflection arising through two distinct modes of reflection, journal(diary)-writing and interview (Pultorak, 1993), are shown in Table 5. The results indicate that written diary reflections made up approximately two thirds of the technical rationality category while only one third of both the practical action and critical reflection categories. The results support the findings from Pultorak's study: namely that from journal-writing tend to emerge reflections pertaining to classroom competency while from interactive interview reflective comment with reference to a belief framework, incorporating human needs, are more likely to arise .

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Table 3

Examples of reflective comment

	Diary	Interview
Technical rationality (classroom competency)	*I had provided enough equipment for all for children to have a choice*	*I know I aimed too high, but it was interesting nevertheless. I still want to stick with my mixed ability groups though.*
Practical action (beliefs in constructivism)	*As I questioned individual children today I found children had to think for themselves, therefore I challenged their thinking*	*In their mathematics thinking I need to acknowledge all the experiences they had prior to school so that I can try to match the mathematics to their interests*
Critical reflection (gender equity)	*I tried to use gender-neutral resources today: pegs, shapes and geo-boards*	*I don't like girls-only days but I ask who wants to go on the Mobilo and if there are girls with their hands up I choose them first.*

Table 4

Number of comments from reflective responses

	technical rationality	practical action	critical reflection
Rachel	19	21	15
Claire	24	16	13
Kylie	17	20	18
Emily	16	11	9
Tracey	7	11	12
Julie	14	12	14
total	97	91	81

Table 5

Proportion of responses according to mode of reflection

	technical rationality		practical action		critical reflection	
	diary	interviews	diary	interviews	diary	interviews
Rachel	.53	.47	.24	.76	.33	.67
Claire	.63	.37	.50	.50	.54	.46
Kylie	.71	.29	.30	.70	.50	.50
Emily	.75	.25	.36	.64	.33	.67
Tracey	.43	.57	.27	.73	.17	.83
Julie	.71	.29	.33	.67	.14	.86
total	.64	.36	.33	.67	.35	.65

Goal setting through reflective practice

This section reports on the process of how the reflective model of interactive interviewing used was able to support the teachers in focusing on individual goals. Teachers reported that the process of interactive interview supported them in their efforts to set goals for themselves. Summaries of the observations and follow-up interviews indicate the confidence gained by the teachers through the shared reflective interactions. Some teachers gained the confidence to intensify their actions and to apply, more firmly, their original intentions. Others used the opportunity to experiment and to modify their usual behaviour. In all cases there was a refinement of planning, in terms of the original focus chosen for observation.

Rachel: My interactions within the teaching group

Observation 1: As Rachel worked with one particular group she demonstrated her ability to seat the children so that all were able to interact with her. She controlled the sharing of equipment in such a way that the quieter children, that day all girls, were able to be provided for comfortably. The task was completed in pairs and allowed the children to explore their own directions, sharing ideas as they progressed through the activity. As the session developed, observation revealed that some children, especially the boys, were now on hands and knees, pushing forward in their enthusiasm to participate and to respond to Rachel's questioning. Questions raised by the observation were: do all the children hear the responses made by their peers? which children do the talking?

Reflection 1: *Well I found the boys tended to be the ones who came out with what they found out whereas the girls would find stuff out and*

they wouldn't really say it, they would just sort of ... have a play
around but not talk about it. I think at the beginning I need to
write down some of those initial ideas, I don't think everybody
could hear those two girls on my left. ... perhaps next time you
could focus on that and see how I go ... paying attention to each
other.

Observation 2: For this observation Rachel had set up an activity where the
children were not allowed to talk. The focus of this was
awareness of other children's needs and collaboration towards
the completion of a task. When discussing the activity with
them afterwards, as a whole class, she encouraged them to
share their feelings when they, for example, were ignored by
other people, or could see how to complete the task but other
people's actions or non-actions got in the way. When she felt
that some children were participating over-enthusiastically in
the discussion, or when she sensed that someone's behaviour,
albeit positive to the mathematics learning, was overshadowing
others, she used the task as a model for controlling changes in
behaviour.

Reflection 2: *It was the same children that were the takers and the snatchers ...*
when they know what's going on in maths, like today when it's
really hard for them to actually see that piece that they need and
wait for it to come to them. I think they found it quite hard ...
realising ... "I actually have to look at somebody else's and say
now which person to give this piece to" ... I think they listened
better to each other afterwards ... I think I ask somebody to
repeat what someone else has said to focus them in ... I must try

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to do that more often.... You really have to encourage them to share and have a look, especially these girls, and make them feel alright, that everyone is going to be different. The goal made me especially think about when I was asking children to repeat what others have said and making sure that everyone was taking notice.

Goal: *Even just thinking about it (the focus) beforehand, before the lesson, just knowing that's what the goal is, that it really makes a difference ... yes it does.*

Claire: **The children's dialogue/interaction with each other**

Observation 1:Claire had provided a motivational activity for the exploration of reflective symmetry in shapes. She seated the whole class in a circle and they worked together on the floor, on a large scale, with leaves and wallpaper. Meanwhile around the tables she had set out a variety of equipment arranged ready for group use. The range of equipment included manipulative material, dough, and squared paper. She put the children into groups and gave them a common task, although variation occurred due to the differences in the type of equipment used by any one group. The children applied themselves to the task with enthusiasm and the maths-talk was plentiful and vigorous. After a set time Claire organised a change of equipment for each group and the children repeated the task. The change of equipment provided a fresh focus to the task, often resulting in a new approach. Observation revealed a key issue for a busy and successful session: what sort of maths-talk took place? what was the quality of the dialogue?

Reflection 1: *I think probably eighty percent of today's talk was mathematical. There was very little off- task talk ... I think most of it was about their shapes and about the symmetry lines which is good. I thought it was excellent talk, I was very pleased. I think starting off with leaves and wallpaper helped because they were familiar to them. That probably helped all the talk ... they could relate what they were doing to the starter material. I'd like to know about what they were talking about though, I was too busy getting round everyone to stand back and listen.*

Observation 2: The session began with the children seated in one large circle. The distribution of calculators caused much excitement and it was clear that the children had recently had opportunity to use them successfully. The mathematical quality of talk was of a high level as the children chattered about the calculators. Claire had suggested that they talk with their next-door neighbour and this encouraged very focussed, paired interaction. After some time for this open exploration she reminded them of the procedure they had used previously and then suggested the variation. The children then moved off to explore in pairs. Children discussed their processes, results and mistakes. They were able to sort out wrong directions by asking questions such as "How did that happen? What did we do wrong?" It was evident that the previous activity had given them the strength, even at this very young age, to be confident about number patterns and, building on this confidence, to work without the calculator and pose questions relevant to their results.

Reflection 2: *It went better than I thought it would actually because I knew a lot of them hadn't had any calculators before. I think some of them had them last year but we haven't actually used them this year and that caused that great excitement at the beginning. I thought "Oh here we go we're just going to get excited about these and forget the maths". But they still got into it quite quickly ... it was just at the beginning they were a little bit excited about it all. I think they learnt a lot, even the ones that didn't know what I was getting at. That's because they asked each other so many questions. That must lift the quality of maths mustn't it because some of them have got to be the ones who answer. It takes a bit of thinking about before you can ask a question as well as finding an answer for someone.*

We started the patterns the other day and they were just so excited with what they found ... just the same as some of them were today and they just kept writing on the board at lunch time, they were just sitting there writing the next number ... they just kept going. I went out of the room and had lunch and there were still children there when I came back, still writing, still predicting the next number and writing the next number down. So I thought "Well I'll just carry on and do some more, only try some variations." Some of those children today, they would find great difficulty in counting in fives yet they were able to say so much about those numbers once they had them down like that ... I mean they were saying so many different things that I wouldn't have thought they knew about.

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Goal: *The good thing about this (observation) is it does make you focus whereas ... all day long, day in and day out ... you don't always remember to do some of those things that you were sure you would do. But then you think "Oh yes I've got my observer coming in tomorrow" so you think about what you going to do and how you are going to set it up in terms of what you want her to look for?*

Kylie: **The quality of interaction between self and children**

Observation 1: This was the second session of a planned unit on statistics. Kylie had chosen to work with the whole class to ascertain their interests and preferences within the context of the data collection and presentation. She had previously stated that she was aware that, in her interactions with the children, she needed to use strategies which enriched the participation for all children . In preparation for the data collecting she initiated a discussion on how you could count a large number of people by putting them into groups of a certain size. She employed a variety of strategies to encourage the children to participate meaningfully in the large group situation: she lengthened her own responses; she responded with another question; she asked children to describe their idea in more detail; she encouraged other children to ask questions of the participant; and she supported her responses with appropriate non-verbal communication. One issue of interest from these observations was: the importance of developing children's own ideas in order to make the mathematics learning more meaningful for them.

Reflection 1: *Some of these children are absolutely fearful ... they want the right answer. Harry, he just curls up if I want him to guess something.... I mean the expectations on that child are so rigid that he wants the right answer every time and he thinks there's got to be one answer, it's giving him a lot of trouble. And Jody is the other one. Now Jody is a very able child. You would notice in every other thing that we do reading, social studies, music ... you name it ... she's full of life. As soon as maths comes she dies ... I have to pull her out of corners. Literally have to haul her out of corners, she just shrinks and yet she's perfectly able. There are a lot of girls like her. I think that there are some girls who just do not perceive that they can contribute in maths because society constructs them to believe that maths isn't part of their world, their interest. So today I tried to make them all feel that what they said was important, not only important in itself, but for the mathematics that we were engaged in. No, I think all children are interested in maths but I want every child that comes into my classroom to know when somebody's got more than them, to know when somebody's got less than them. They've got all sorts of mathematical concepts already, integrated into their whole being so they know lots and lots of things. And it's the teacher's role to bring out these things and to build on them.*

Then there are children in here from other cultures who don't have the same links, the same maths links as I do. Talking to each other in maths language, not because of the language barrier, but because of their whole experience, their whole cultural constructions are different ... I think now I need to look

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more at how the children react to each other, how they interact when there are all these different forces in action.

Observation 2: For this session the learning experience had been planned around small group activity in order to increase the opportunity for children to listen and respond to each other within the mathematics context. The set task was to design a procedure for collecting data, each group having decided previously which particular aspect of the survey they wished to explore. Kylie had already led these young children through a comprehensive process of brainstorming by talking and drawing pictures of things they wanted to find out more about and had planned that this session the children would replicate this process in their groups. In every group the children seemed to seat themselves comfortably and there appeared to always be someone who would check that all could see and hear what was going on. The intensity of their concentration included a high degree of non-verbal language and it was rare to find two children talking at the same time. It was clearly evident that the previous focus on the actual process of decision-making had been successful. When in doubt there was always Kylie for support, and the children often looked to her for clarification of what any particular group member wanted to emphasise. There were no instances of children trying to either overwhelm or talk over others: an important factor in the provision of equality in the classroom.

Reflection 2: *It is a bit ambitious perhaps but it seems to be working. There are other things I could have done, like just get them to count*

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*things. But I like to give them the opportunities to do more, to
make sense of what they're doing. I worry sometimes that I ask
a lot of the children but I think you can give children experience
of something quite complex, and something that is quite
structured, if you carry them along part of the way. There are
parts that they can do for themselves but they have to learn how
to work together ... even these very young children managed to
listen to each other and more than that, to make use of what
other people said ... but as a teacher you must pull back, you
must know when to let go. I'm a whole picture person, I don't
like bits, I need to see the whole picture. So I believe in that for
my maths teaching ... I can deal with things the children can't
deal with themselves but if they listen and respond to each other
they can also get an overview instead of feeling that they can't do
it, perhaps, by themselves.*

Goal: *I quite like having it (a focus), because I like people in my
classroom ... I don't feel threatened. One of the things I've found
about teaching, even in an open plan area, is that it's a very
solitary experience. If somebody else is there it's wonderful,
because they see things that I don't see.*

Emily: **The learning behaviour of the independent workers**

Observation 1:Emily believed in using social groupings for the children's
permanent places in class. The seating arrangements for this
mathematics session followed the usual pattern with most
children moving from the whole-class activity on the mat to
their normal seats. Emily preferred children to feel
comfortable and work near their friends. While she worked

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with one group the other children worked on an independent task. Observations revealed that five girls, in particular, completed the main tasks very quickly and then spent the time answering questions and giving assistance to the other children. The children appeared to be so accustomed to this habit that they were calling out to these girls for help while they were moving amongst them, in the style of a supportive teacher. A question arising from this observation is: what level of mathematics might these girls be achieving if they were free to develop their ideas further?

Reflection 1: *I think the setting of the scene before you send them away is very important to get talk about what you want, rather than what they might be doing this afternoon, and that we do some sort of preliminary activity. As a group we'd pretty much done the preliminary work to that sheet. We'd talked about it, they'd had a prescribed task ... so this was a lead on from that to see if they could apply that sort of taught knowledge to actually do it themselves ... to make something up ... it gives them a chance to demonstrate what they know, or hopefully to experiment ... they're in control.*

Now culturally, the girls are less likely to take a risk, to do something that they're unsure of. Whereas the boys are keen to have a go ... well, you just have to look at the cultural dancing. The girls are standing up the front doing their beautiful hip swaying and arm moving, singing sweetly and the men are all much more active at the back, moving forward and bringing themselves right up front. So therefore I always think my girls

are going to be less likely to take an active part in things. But in this class, on the whole, my girls are pretty smart, they are sort of dominant ... so it doesn't surprise me at all that they lead the way. It does please me but I know that some of the girls use a lot of their maths time helping the other children and not getting enough challenge themselves. I wonder what would happen if the children were grouped into girls and boys? Maybe that would affect what they are doing when they are working independently?

Observation 2:For this session Emily seated the children in particular places for their independent mathematics task. In particular she arranged for the five mathematically-able girls to sit together at one table. The girls worked at length, sharing in each other's work. They discussed individual strategies, they shared results and moved confidently on to the more open section of the task. They sang together while they worked and their collective image seemed to send out messages that they were busy and not to be disturbed. On one occasion one of them approached Emily with a question and then relayed her response, a prompt, to the others. Together they negotiated amongst themselves to put meaning into her response. The level of mathematics achieved, and the mathematical processes they engaged in, seemed to be greater than in the previously observed session.

Reflection 2: *I was amazed at the speed at which the girls completed their task. That shows they are a nurturing lot ... usually they'd have been busying themselves helping others. They weren't hindered. Their access to further learning just opened up. The girls struck*

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me as far more independent ... when they completed the task they came to me ... and I said to one person, one of the girls, "This is what I want you to do, now you go and show the rest of the girls at your table." So all the girls knew what they were doing and I was free to deal with the boys who used me instead of those able girls.

Goal: *I like having someone in the room with something specific to focus on. I know all these things but the classroom life is so busy that it's good to take time to really think about them.*

Tracey: The learning styles of the children

Observation 1:Tracey's learning experience had been planned to cater for the individual. In her class of predominantly children whose first language is not English this had meant a focus on the practical experience. Her resources were planned so that children could express their understanding of mathematics through the resources. Her planned tasks were also designed to give her opportunities to assess the children's understanding through observation of individuals in both independent and in group situations. In order to cater also for the different ethnic and cultural expectations of the children, reflecting family and community values, she had set up learning situations which placed different social demands on the children.

Some children chose tasks where they could work independently while others preferred the tasks organised to support collaborative thinking. The tasks, which were set up for children to work on in pairs, identified an intensity of on-

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task behaviour in some children that was not apparent when they were in the whole-class situation at the beginning of the session. One question arising from this observation is: are the individual children, in terms of gender, advantaged by the provision of a choice of learning styles?

Reflection 1: *I allow them to choose how they want to work but I always plan to have a check on what they are choosing and sometimes I decide there are too many boys ... but I like to let them choose. When they're all in one huge group, like today counting the money ... one of them grabbed it all and she started counting ... and because of the age-range in my room ... she's the oldest one, that girl, she tends to be dominating, to be bossy about things, especially with the younger girls. But that's not only her personality, it's also the way she is expected to behave at home. I probably need to make the money-task more structured for such a large group ... but I persevere with that because I think they should be able to sort it out amongst themselves and I hope that by letting them just go for it they might develop some strategies but I think perhaps I need to intervene on that.*

Those small groups once I gave them the balance I think they got the idea, and they worked together ... one on each side and one in the middle and they just tipped until one was heavier. I did notice though that the boys did the filling every time. Then I put those shapes for them to work in pairs. It's hard work for me to put things out like this, but I set it up for pairs like that because some of them like to just work with one other person.... In terms of the learning I do find that with a smaller group the younger

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ones are more involved for themselves ... and when I think about it ... those two groups of boys, clicking together and feeding off each other, have a different experience from my girls who mostly like to work quietly, silently really, on their own or in pairs. And I suppose I can identify the learning more quickly in those boys' groups because they're loud. Perhaps you could move to the girls and look at instances of where girls are taking a passive role and I'll see where I can go from there.

Observation 2: For this session Tracey had set up learning stations to both support her belief in the importance of individual choice of tasks and also allow her time to do the required checklisting of mathematical skills as expected by the school assessment structure. Instances of male behaviour which affected the mathematical activity of the girls were observed. These included: a boy physically removing a girl's hands off some equipment he wanted to use resulting in the girl then standing and watching his activity; two boys laughing at the efforts of one of the girls who then moved off quietly to another station; three boys' loud behaviour, although on-task, interrupting a pair of girls working quietly at the next table, who then sat and watched the boys but took no part in any mathematical activity themselves. However, at completion of the checklisting task Tracey moved around the room and used a variety of strategies to increase the active participation of the more passive children. She encouraged the girls who were working in pairs or individually to engage in their activity and talk to her about the task. She sat with the mixed groups and introduced a strategy for turn-taking. She listened to the

enthusiastic contributions of the louder group, all boys, and then controlled their collective noise level.

Reflection 2:   *Yes, today's made me aware of instances of girls sitting back and watching boys doing things. Especially when I went round to try to involve them more..... It was good going round and just looking at instances where girls were taking a passive role . I'll watch for it now because it is very easy to let it happen and just not be aware ... I think awareness is the key ... and then strategies revolved around being aware of it and just refocussing - very low key.*

Goal: *It (a focus) makes me think about my own maths programme and it's given me the opportunity to get feedback on my maths programme which is what I want. But I wanted it from a person who I thought could be objective, like not involved in the school, so it's perfect for me it's just what I want.*

Julie: **The learning behaviour of the independent group**

Observation 1:Julie planned the learning experience to develop in small groups from a whole-class starter activity. During the initial activity she successfully used a variety of strategies to ensure that all children were included in the discussion. Once the children were seated in their usual mixed-gender groups she described the task clearly. As the children worked on the task Julie moved amongst them and monitored their individual directions. She needed to focus on management strategies to maintain on-task behaviour and to ensure that the less overt children were feeling comfortable. This decreased her capacity

to engage in mathematics-talk to encourage and develop the children's thinking. The observation raised the question: how to use effective management strategies to enhance the involvement in the actual mathematics learning for the girls while still addressing the overt behaviour of the boys?

Reflection 1: *I'm always sitting there thinking I haven't asked enough of the girls ... you know. enough depth. I think "Oh the boys are calling out a bit, I'll have to quieten them down so I can ask the girls." I think next time you come I'll try arranging my groups on a gender basis, I'll have boys at one table and girls at the other. Then we'll see if the girls communicate better amongst themselves.*

Observation 2: For this session Julie was teaching half the class only. The planned learning experience began as a whole group with a discussion about the three-dimensional shapes around the room. She then introduced some wooden solid shapes and a discussion followed about the properties of these shapes. She arranged the children around two sets of tables: a group of girls only and a group of boys only and provided dough as the contextual medium. There were clear differences in the use of the dough with the girls applying themselves immediately to the task in hand: to make some shapes with the dough. The boys played around with the dough at first, experimenting with it in terms of pulling, rolling, flicking. As the girls were at a separate table they were unaffected by this behaviour and able to concentrate on each other's shapes. The mathematics-specific dialogue was busy and rich. Continued observation

revealed that the boys became attracted to the questioning and conversation that Julie was engaging in at the girls' table and this encouraged them to move on-task.

Reflection 2:   *Well I chose dough because I thought it would more interesting for the girls, more part of their experiences. I thought the shapes would probably mean more to the boys so I chose to balance it up. It was much easier to move around one-to-one with individual children. So that when that girl made a worm or ... they made a shape which wasn't necessarily like the wooden ones we had been using ... it was easier to ask "OK then, what will happen if we cut this open? What shape do you think we will see?" ... I can picture that if they had been sitting mixed up ... the boys would have been showing off about it and the girls would just sit back. They are not an aggressive group of girls and they might not have had any part in the learning at all. Another thing I did was give the boys a rougher dough. The girls like a softer dough because it's not so cold. They definitely like it warmer ... so I did that because I thought if they were more comfortable they might get into it more and talk about it. I tried that today because I knew I was going to seat them in single-sex groups.*

Goal: *It's been part of my learning, to be more aware of gender and how the girls and the boys are learning ... and I'm really aware that my girls do get affected by the boys' behaviour. But it's really good to have someone come in and help me to focus on them.*

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Through the combination of written and oral reflection the teachers in this study were able to benefit from a multi-focused approach to the planning and evaluation of their classroom programme. In particular all teachers highlighted the positive support, in focusing on a particular issue, provided through interactive, observer-based, reflection.

4.8 SUMMARY

The most important aspect to arise from these results is that although the methodology used for the study was a collection of individual case studies, the trends and commonalities which became apparent allowed the study to be reported on collectively. This enabled the results to be examined by focusing on the critical issues that emerged and these issues are discussed in the following chapter: namely the influences on practice of teacher-belief, of the curriculum, and of the demands of professional survival during the first year of teaching.

CHAPTER 5

DISCUSSION

This study set out to explore the relationship between the beliefs and practices of beginning teachers of mathematics in primary schools. The original focus was to have been on the teachers' ability to put into practice their beliefs about providing equity in the mathematics classroom within a gender-sensitive framework and to explore whether their beliefs as pre-service teachers were affected by their actual experiences as first year teachers. During the course of the study, however, it became obvious that the beliefs held by these teachers at their pre-service stage was only one factor influencing their ability to provide equitable access to the mathematics learning for both girls and boys. Having identified some of the other influences impacting on their ability to plan and implement a successful classroom mathematics programme the focus of the study became the actual practices of these teachers and how these practices were affected by three major influences: beliefs, curriculum and professional survival.

5.1 INFLUENCES IMPACTING ON PRACTICE

The three major influences identified were explored for their impact on these beginning teachers in an attempt to gain a broader body of knowledge about the first year of teaching. Studies focusing on one particular aspect of classroom life are valuable but subject to the many constraints of the complex classroom environment (Koehler & Grouws 1992). The case study methodology used was intended to allow these constraints to be valid aspects of the research. Although the study focused on the teachers' mathematics programme, and in particular its provision for gender equity, the results provide an insight into broader aspects of the first year of teaching. They explore not only how the beginning teachers were able to organise and

implement their own classroom programmes but also how these teachers perceived their intentions to be affected by the need to become socialised into the ways of their institution. The three major influences through which this research was conducted are detailed below.

- **beliefs:** how a multitude of experiences over a period of time influenced the values which formed these teachers' beliefs about the teaching of mathematics and how these beliefs can be adjusted or strengthened as teaching experience increases.

- **curriculum:** how the current constructivist culture within mathematics education affected the planning and delivery of mathematical experiences for these teachers. In particular, how the need to provide for rich mathematical activity based on child-centred learning was implemented, together with appropriate assessment of this activity.

- **professional survival:** what constraints and opportunities faced these first year teachers within their institutions. How teachers confronted these constraints and capitalised on opportunities as part of the process of socialisation into their school's culture.

Although the findings will be discussed within these three categories, due to the complexities of classroom research, there will be overlap of the boundaries. Overall, the teachers were confident about their mathematics programmes, thought deeply about their children's needs and were reasonably comfortable within their school environments. The study raised possibilities for further exploration of, and support for, the provision of a

mathematics classroom climate, in the first year of teaching, that was safe and enjoyable for both girls and boys.

5.2 BELIEFS AS AN INFLUENCE ON PRACTICE

Personal experiences of mathematics

The majority of students entering pre-service teacher education programmes already hold strong beliefs about mathematics and mathematics teaching (Mayers, 1994). Mayers' study explored how these beliefs were affected by participation in mathematics education courses which were designed within a constructivist framework. The results showed that as well as developing more positive attitudes towards mathematics itself, the students developed constructivist beliefs about the teaching of mathematics.

This study identifies some of the specific aspects of their mathematics education courses which the teachers had found of use to them during their pre-service stage. Familiarity with the current curriculum rated highly as a means of developing beliefs in keeping with current philosophy. Within the courses, the modelling of classroom situations, by providing practical experiences for exploring mathematics concepts, was stated as contributing greatly to the development of personal beliefs - 'belief-formation through experience.'

Experiencing mathematical power themselves (Mayo, 1994) as pre-service teachers, did much to undo some of the more negative feelings held by many of the teachers on entry to college and provided them with a belief in the potential for mathematical richness within their own programmes. In all but one case this indicated a considerable shift from previously held beliefs based on their own experiences of school mathematics and these findings support those of Condon, Clyde, Kyle, and Hovda (1993), and Laurenson (1995). One

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teacher described her secondary school experiences very positively and described how the resulting positive attitude strengthened her confidence in all her mathematics education courses. This is consistent with the findings of Sullivan and Leder (1992) that prospective teachers entering pre-service education already have pre-conceived beliefs about mathematics teaching due to their own school mathematical experiences.

Teaching mathematics through constructivist principles

The teachers in this study held strong beliefs about a constructivist approach to the teaching of mathematics, due mainly to the experiences of their pre-service mathematics education and this is consistent with the findings of Mayers (1994). A further aspect of their pre-service mathematics education courses found to be of benefit was the focus on the child's development of understanding and of the child's way of learning, as described by Mousley (1993), Leder (1993) and Begg (1995a). In keeping with constructivist theory the pre-service mathematics education courses had emphasised the importance of focusing on the child. All the teachers, in the current study, now espoused the beliefs that the learner holds a key position in the developing of mathematics learning (Ernest, 1992; Keiny, 1994). They valued highly the contributions of the children and encouraged 'maths talk' amongst the children themselves, regarding this as an important aspect of the mathematics classroom. Their commonly held belief that social interaction which encouraged negotiation of meaning is an essential ingredient for rich mathematical learning is consistent with social constructivist principles, as defined by Ernest (1992).

The realism of the classroom, however, had made the teachers conscious of the need to question where constructivism fits within the overall structure of a classroom programme and this was evident in their definitions of their own

practice. The findings are consistent with those of Ford (1994) who writes of how, despite having formulated theoretical beliefs about aspects of teaching prior to entering the classroom, pre-service teachers nevertheless have yet to have these beliefs reinforced by experience in the classroom. Reinforcement of beliefs can result in an adjustment of previously held beliefs in terms of both strengthening or contradiction. The teachers all commented that positioning themselves on the belief continuum (Laurenson, 1995) which defined their perception of themselves in terms of constructivism was affected by the reality of the classroom situation. The teachers' reacted positively to the goal-setting process, within the on-going structure of reflection and action of the study, as a means of integrating their thoughts on beliefs and practice. This confirms the assertion of Clark and Peterson (1986) that thought processes and action are inter-related.

In terms of gender-sensitivity within their own mathematics classrooms and programmes all the teachers claimed that they needed to use strategies, in keeping with their beliefs, which allowed the girls increased opportunity to take an active part in large group, or whole class, situations (Willis, 1989; Fennema, 1990b; Zevenbergen, 1993b; Solar, 1995). They attempted to utilise their beliefs in constructivist principles to enable them to exert control over the more overt and sometimes overwhelming behaviour of the boys in these situations. Constructivist strategies used included using paired activity to encourage maths talk, using concise starter tasks which enabled the resulting mathematics activity to be followed up in a variety of ways and allowing the children to choose their own social groupings, rather than work in pre-determined ability groups.

The teachers differentiated between girls and boys only to the extent that they strived to maintain equity in terms of ensuring that none of the children

were denied access to the learning. The predominant belief was that they should give the right learning tasks to the right pupils, supporting the findings of Hanna (1994) and Sutton (1995).

The results of this aspect of the study indicate that 'experience' includes not only their own personal experiences as a learner but also their current classroom experience.

5.3 CURRICULUM AS AN INFLUENCE ON PRACTICE

Provision of tasks which encourage rich mathematical activity

The philosophy of the current New Zealand mathematics curriculum is embedded within a problem-solving approach to the learning of mathematical concepts, based on constructivist principles, and is described in Chapter 2. The teachers in this study felt that the curriculum was a strong influence on their practice, supporting not only their beliefs but also their ability to implement their classroom programme, as advocated by Mousley (1993) and Mayers and Britt (1995). They identified the curriculum as a supportive tool for effective planning and felt that it was of more use to them than school schemes or criteria for assessment, as it completely supported their beliefs in constructivism.

However, it is widely recognised that curriculum alone will not provide a successful learning environment (Romberg, 1993; Howson, 1995; Neyland, 1995). It is in the delivery of the curriculum that classroom practice can differ and the successful delivery of a curriculum, successful that is, in terms of current philosophy, also requires a firm belief in that current philosophy. Howson talks about strong teachers and weak teachers. Using Howson's definition, the teachers in this study could probably be defined as strong teachers, in that they held strong views about their mathematics teaching

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and about their ability to 'do their own thing', as much as possible, within the environment of the school to which each belonged. They were in their first year in the classroom when they were probably at their most vulnerable in terms of fulfilling the expectations of their school's requirements (Lortie, 1975; Zeichner & Tabachnick, 1985; Goodman, 1988; Kuzmic, 1994) and they were comfortable being able to refer to the curriculum as a justification for some of their desires and actions.

The teachers provided tasks which encouraged rich mathematical activity, as defined by Ahmed (1987), Bird (1992) and Shiu (1992). They believed sincerely in valuing the contributions of the children, namely listening and hearing the sense of what children say, and allowing even the very young children to construct their own pathways for learning (Confrey, 1991; Simon & Schifter, 1991; Steffe & Kieran, 1994).

Some of the ways in which the teachers wished to run their classroom programmes differed from the culture of the mathematics teaching environment within which they were expected to function, as recognised by Goodman (1988. Using the curriculum as a reference for justification they felt able to provide situations where children were able to think more for themselves and to have increased input into the actual mathematical knowledge. The curriculum provided exemplars which the teachers felt justified in trialling. In some cases their ideas were encouraged by the key people within the school. Yet there were other situations where the teachers felt safer if they trialled their own ideas in the privacy of their classrooms while then displaying different behaviour when in contact with these key people. Key people include tutor teachers, syndicate leaders and mathematics specialists.

Teachers found the curriculum influenced them in their ability to provide learning experiences which maximised access to the mathematics learning for all children. One strategy commonly used to increase the active participation of the girls, for example, was the focus on meaningful context, as recommended in the curriculum, as identified, as an essential component of gender-inclusive teaching, by Kreinberg (1989), Solar (1995), and Burton (1995). One teacher in particular was reluctant to recognise gender as a contextual factor in the provision of tasks which encouraged full and rich participation and activity, preferring to focus on the 'individual'. However, she stated that focusing on this issue had raised for her an awareness of the different strengths and interests that girls bring to mathematics as stated in the curriculum. As well as contextualising the mathematics to suit both girls and boys, other strategies to increase the active, rather than passive, participation of girls were trialled. These were also taken from the current curriculum: examples included social situations such as collaborative tasks, which encouraged risk-taking and shared knowledge (Ministry of Education, 1992).

Assessment of the children's learning

A common view expressed by the teachers in this study was that assessment methods used in their schools tended to be mainly the checking of children's performance in terms of behaviourist tasks, and this is consistent with the views of Neyland (1995). The teachers felt that these performance-based assessment procedures limited their ability to report fully on the mathematics learning and understanding of any one particular child. The objectives tended to be content-based, individual tasks whose assessment left no room for the mathematical process recommendations of the curriculum (Lajoie, 1992; Ministry of Education, 1992; Romberg, 1993; Begg, 1995b; Clarke, 1995).

The teachers were determined to add to their personal records of the children by using the curriculum fully to support them in their assessment of both the content and processes apparent during a mathematical experience. All the teachers believed that observation details of the children needed to be broadened to include recordings of what some children could to that exceeded any specific standards that might be expected of them in terms of content skills. This is consistent with the recommendations of Bird (1992). The teachers expected to be able to record these broader assessment items, such as instances of children posing questions, negotiating with others or risk-taking, within the learning.

The teachers felt frustration at the devaluing, within their school environments, of their assessment of quality mathematics (Mousley, 1993; Begg, 1995). Some of the teachers were familiar with resources which include material allowing for the assessing of process skills such as problem-solving and the communication of mathematical ideas. It was felt by all that material was needed to support the assessment of constructivist-based learning, and this is in keeping with the recommendations of Howson (1995). One teacher in particular was disappointed that in her school the richer aims of a constructivist-based curriculum were being broken down into a set of behaviourist objectives and the children assessed accordingly (Neyland, 1995).

5.4 PROFESSIONAL SURVIVAL AS AN INFLUENCE ON PRACTICE
Internal and external expectations of teachers
Knowledge of curricula, together with pedagogical practice, equip pre-service teachers to embark on their first year of teaching with a set of intentions for

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their own classroom practice. In this study these individual intentions will be known as the *internal* expectations of teachers.

Any teacher has to be accountable for not only their classroom practice, but also for their ability to fulfil the wider institutional expectations of the school. Each institution has a culture of its own: its set of practices and routines in terms of the management of both learning and behaviour, and its commitment to parental and community obligations. For the purposes of this study the demands of the institutional culture will be called the *external* expectations of teachers.

The level to which these external expectations impact on an individual teacher's intentions can vary, depending, for example, on the degree of agreement or conflict between the internal and external forces, or the length of teaching experience of the individual. As a result of these forces, individual beliefs may be changed or reinforced. According to Veenman (1984) and Renwick and Vize (1993), first year teachers are likely to be most vulnerable to the influences of these external expectations, yet the results of this study do indicate a high level of determination to hold on to beliefs.

The findings from this study elaborate on ways in which these teachers successfully used a structure of reflective practice to identify ways to achieve a balance between the external and internal expectations of them, in this vital first year of teaching.

Socialisation into the school environment
The findings of this aspect of the study are the opinions of the teachers when asked to reflect upon the external expectations of the school in terms of the mathematics programme. Entry from pre-service education into the

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teaching profession is very sudden (Veenman, 1984) and in terms of primary classroom teaching, and the day-to-day accountability for the children's learning and welfare, a beginning teacher carries similar, if not the same, responsibilities as a classroom teacher with many years experience. This level of responsibility determines a certain degree of independence from the very beginning of her existence within the school environment. The degree of independence achieved, or often desired, by any individual can be defined as the extent to which the teacher is able to accommodate her internal expectations within the framework of the external expectations on her.

All the teachers in this study demonstrated aspirations towards the independent status expected of a classroom teacher and for taking responsibility for their classroom programmes. This is evident in their confident decision-making within the confines of their own classroom and in their willingness to share their views whenever possible within the wider decision-making processes of the school. Reflective comments on the mathematics environment within which they were expected to function gave rise to both opinions about existing procedures or beliefs within the school, and decisions for change that the teachers had been able to implement within the autonomy of their own classroom. The findings from these reflections, as categorised within the social-strategy framework designed by Goodman (1988), are consistent with the findings of Zeichner and Tabachnick (1988) who matched the responses of the teachers in their study to the model defined by Lacey (1977).

The results indicate that none of these teachers gave responses supporting a willingness to fit into any procedures of the school they felt totally undesirable in terms of their children's mathematical experiences. This indicates a strength to act according to belief if the expectation of the

institution is seen as too big a constraint to comply with (Regan & Hannah, 1993). However in terms of the stated responses, the spread across the categories in the Goodman (1988) model and the range of issues highlighted, would indicate the differences in external expectations facing each individual teacher in any one institution. This supports the findings of Veenman (1984), that the issues deemed to be problematic by beginning teachers are both person-specific and situation-specific.

However the teachers in this study did not only reflect on their mathematics programme from a problematic perspective. Teamwork and cooperation are also important contributors to the provision of a mathematics programme which maximises the learning potential for all children and these teachers included in their responses a willingness to learn from both their tutor teachers and their syndicate leaders. There were expressions of interest in procedures which were new to them, as well as efforts to understand expectations and to compromise on those which seemed alien to their personal beliefs about ways of providing equity within their mathematics programmes.

Reflective practice: journal-writing, theory and practice

The key issues identified by the teachers as categories to be used in their journal-writing indicated a focus on making mathematics learning meaningful and enabling for the children. At the time of making this collaborative decision the teachers were just completing the first term of teaching, in their fourteenth week in the classroom, and the choice of issues still reflected the constructivist framework within which they had received their pre-service mathematics education.

The framework that the teachers constructed for the diaries illustrates the depth of understanding these teachers showed towards the provision of rich mathematics programmes. It is a common notion that a first-year teacher's focus is on day-to-day survival and that classroom-planning tends to include strategies biased towards management of behaviour rather than enrichment of the curriculum and earlier works, in particular, support this view (Lortie, 1977; Van Manen, 1977). The findings from the diary statements are consistent with this view, that is, the written reflections and responses to these issues, do show a tendency to focus on classroom competency (Pultorak, 1993). The design of the framework, however, does allow teachers to include their intentions of providing constructivist environments even though their responses were of a more practical nature.

A point of interest arises from this contradiction between planned issues and the teachers' responses to these issues. The contradiction, while supporting the theory that in the reality of the classroom the all important issue is one of survival, nevertheless illustrates that the teachers' planning for the delivery of the mathematics curriculum was still embedded in an enthusiasm for addressing learning in a manner which catered for the needs of the individual.

Interactive interviews as a component of reflective practice

Once the teachers had set the focus for classroom observation it was intended that the research process would cater for individualised direction according to each teacher's reflections in the interview situation. The case-study nature of the process at this stage allowed for goals to be set to help increase the depth of focus on the chosen issue. The summary statements of these interviews indicate how these self-set goals arose within the natural setting of the interactive shared reflection. This is in keeping with the findings of Pultorak (1993) who reported that it was during the interactive-

interview phase of a reflective structure that areas for follow-up were determined collaboratively by teacher and observer.

The success of this process also supports the notion that given an interactive structure within which to reflect, the level of reflection includes comment which addresses the needs of the learners and the suggestions for further directions are based on the self-beliefs of the individual teachers (Kuzmic, 1994). In refining or intensifying the focus, the teachers shared a common desire: to increase the access to learning for some or all of the children, within the scope of each individual central issue. In keeping with the gender-sensitive context of this study, it should be noted that some teachers set their focus in terms of differences between behaviour of girls and boys whereas others felt that access would be more equitable if they focused on strategies for increasing access for the individual, irrespective of gender.

Written or interactive reflection?

This study's approach, using a three-phase reflective structure similar to that used by Pultorak (1993), confirms his findings that interactive reflection, of an oral nature, elicits a higher level of critical thinking than does written evaluation. The structure used in the current study is represented in Figure 3 and identifies the adjustments to the nature of the focus for each individual teacher as she moved through the changing reflective process.

In using a structure which includes both written and interactive reflection the teachers in this study were able to relate their evaluative thinking to a broad range of classroom issues. The variety of reflective modes, embedded in the process of reflective practice, allowed the teachers to set more refined goals as they narrowed their focus.

Reflective Process	Focus	The Study
diaries	**key issues**	Stage 2
discussion of issues	**individual focus**	Stage 3
interactive feedback	**refined focus**	Stage 4/5
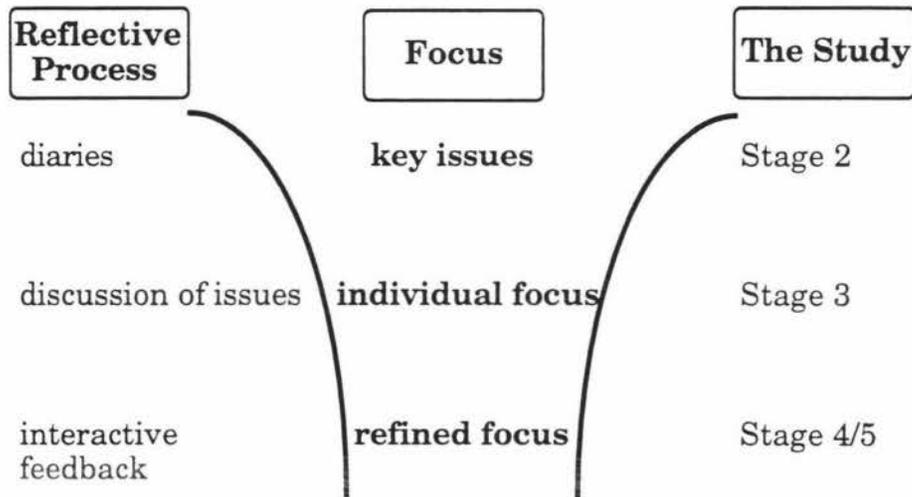
Figure 3   The reflective structure of the study

5.5 SUMMARY

The rewards of inquiring into one's practice are rich. Affirmed that we are having our intended impact on our graduates, encouraged that their work is valued by others, and wiser because of new understandings, we are recommitted to our own work as teacher educators.

(Regan & Hannah, 1993: 311)

The current study begun as an exploration of what it is really like 'out there' in their first schools for six beginning teachers. There were no expected outcomes except to explore the relationship between their beliefs and practices, and to collect a breadth of information about what was happening inside the teachers' classrooms in terms of their ability to implement equitable mathematics programmes in keeping with their beliefs. As the study progressed it became evident that this information would also provide knowledge on the relationship between the pre-service stage and the first year's experience for these teachers. Further findings allowed consideration of

affirmation for, or adjustments to, the expectations of the pre-service educators who had provided for these teachers.

The findings, together with reflections on the process itself, confirmed the complexity of classroom research as described by Koehler and Grouws (1992). As the results show, the three major influences on practice identified by this study are beliefs, curriculum, and professional survival. These influences were identified as a result of the teachers' own contributions to the study. The relationship between the multiplicity of factors contributing to each of these influences, which in turn contributes to the provision of a successful classroom programme is illustrated in Figure 4.

Episodes from each teacher's classroom life have been combined to explore whether similarities do arise with respect to specific aspects of the study and sometimes themes have occurred which suggest implications across a broader perspective. Hence the findings of the study lead to the dual summary focusing on

- the individual teachers
- the group as a whole

The individual teachers

The teachers' intentions to provide an equitable mathematics programme, based on their espoused beliefs at the beginning of this study, indicated their expectation that through behaviour consistent with their intentions they would allow both girls and boys equitable access to, and participation in, mathematics learning. All the teachers were able to implement their intentions and the degree to which this was possible is recorded in detail in Chapter 4. These intentions, together with the teachers' responses and behaviour during the study, are summarised in Table 6.

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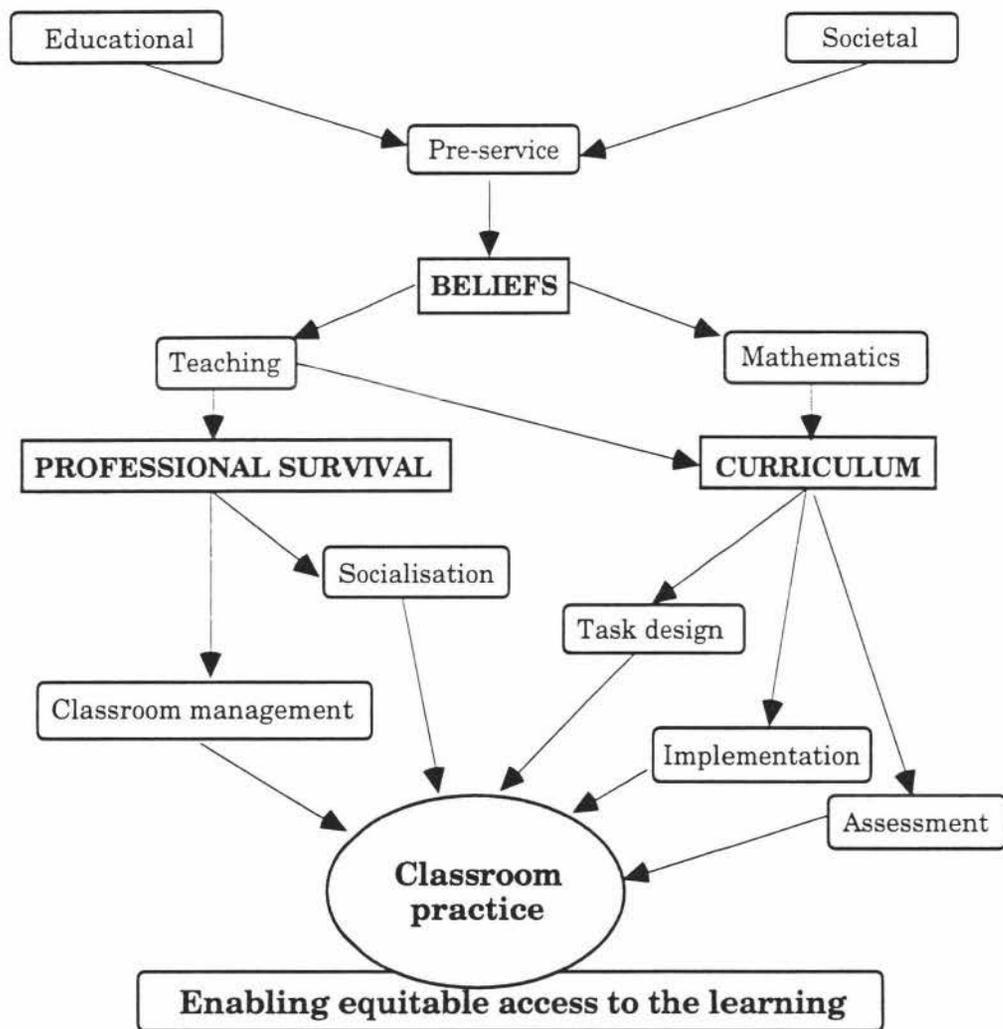
Figure 4   Factors influencing equity in the mathematics classroom

Table 6

The achievement of goals

	Teacher intention	**Evidence arising from the study**
Julie:	To motivate through the provision of a variety of resources	Experimented with material which held particular appeal for different children
Emily:	To enable the children to enjoy their experiences	Used a variety of motivational techniques to interest the children
Claire:	To include the children's contributions in the learning	Persevered to implement learning experiences which capitalised on children's thinking and active involvement, despite the unease of her tutor teacher
Tracey:	To focus on the needs of the individual	Discovered that despite an initial reluctance to address issues from a gender perspective there is a need to give it a specific focus at times
Rachel:	To teach through open-ended tasks	Re-organised her class programme at her tutor teacher's suggestion, to enable increased access to the tasks
Kylie:	To value the children's prior knowledge	Was able to manage classroom activity which allowed the children opportunities to share their prior experiences

The group as a whole

These teachers were in their first year of employment and the common factor to emerge, in terms of both their classroom mathematics programme and of their survival within the mathematics culture of the institution, was the influence of their recent pre-service education. The results gave a clear indication that their pre-service experience in mathematics education *was* assisting them through the first year of teaching by

- focusing them on children's individual mathematical needs
- raising their awareness of the ways children learn
- giving them experience of a constructivist philosophy
- demonstrating the effects of this philosophy on curriculum delivery
- supporting the provision of equity within the classroom
- giving them the confidence to refrain from being subjected to teaching practice which they felt was undesirable in terms of the children's learning
- by giving them experience in reflective practice which enabled them to not only stand by their beliefs but to make change if necessary

The results indicate that the philosophy of their teacher-education provider to provide a pre-service programme based on reflective practice, in both its process and self-evaluative capability, is an important support mechanism for the beginning teacher. The reflective practice, during the pre-service stage, of these teachers, on both curriculum and pedagogical issues had clearly given them the confidence to not only reflect on the behaviours of themselves and others but to take action to overcome any which they thought might lead to less favourable outcomes. This is in keeping with the principles of Shulman (1987: 20) that in order to teach with pedagogical

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excellence pre-service teachers need "a proper understanding of the knowledge base ... and of the complexities of the pedagogical process ...".

Overall the teachers in this study were confident about their mathematics programmes and thought intensively about the needs of all their children. The findings established that beliefs of beginning teachers, based on sound principles, can in fact prevent them from becoming disempowered by their institution.

CHAPTER 6

CONCLUSIONS

6.1 REFLECTIONS ON THE STUDY

While the case study methodology used for this study means that the results are not generalisable to all beginning teachers, the common experiences of these teachers led to the overall conclusion that

- beginning teachers' do hold strong views, or beliefs, on both their own mathematics and on the teaching of mathematics

- these beliefs do affect both their classroom behaviour and their willingness to be socialised into the broader culture of their school.

The case study methodology allowed the approach used to focus on the social and cultural aspects of being a teacher (Huber & Marcelo Garcia, 1993). This approach attempted to include a broad view of life in the classroom while also relating this to the support structure of the school.

The reflective nature of the study gave the teachers opportunity to examine some of the outcomes resulting from their intentions and to recognise how changes, often very small changes, in their planning or behaviour could enhance the learning experiences for their children. The most successful teacher change is effected through teachers controlling their own professional needs (Britt, Irwin, Ellis, & Ritchie, 1993). The findings support the beliefs of Stanic (1989: 38) who writes

> Teachers given the opportunity (to research their own practice)
> can become extended professionals and can further develop their
> own ideas about teaching and about the nature of education.

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The teachers in this study decided for themselves whether to reconsider or modify their actions through their collective and individual input into the issues explored.

Writing about the use of qualitative methods of researching the experiences of beginning teachers, in order to really hear what they are saying, Huber and Marcelo Garcia (1993: 155) recommend that researchers stay "... as close to the phenomena as possible and assist people to speak in their own voice." The structure developed for this study was an attempt to really hear these first year teachers and the breadth of the phenomena resulted in a broad overview of classroom life, from the teachers' perspectives. It was to be expected then that the complexity of the model would generate several issues which could be explored in more depth by further research and these are recommended below.

6.2 IMPLICATIONS ARISING FROM THE STUDY

A major implication from this study is the possibility of developing alternative support structures for first year teachers. Further research is needed, focusing on both beginning teachers themselves and those who are part of their support structure, to strengthen the support during that vital first year. In this way, the more specific needs of both the beginning teachers and their schools could be ascertained.

A second implication is for further research to explore the relationship between constructivism and gender-sensitivity. How do the effects of providing for constructivist learning, support or conflict with theories on the advantages of gender-equitable mathematics programmes?

Another implication is whether trends evident in the classroom environments of these teachers would continue to appear beyond the first year of teaching?

Detailed recommendations to support these implications follow:

Inclusion of the school community

The findings from this study arise from the beginning teacher perspective only. Would research within the wider school community enable the development of a range of strategies for enhancing the paths by which first year teachers become full and valued participants within their schools? An investigation of this nature could include not only the beginning teachers themselves, but also the tutor teachers, syndicate leaders, principals and Board of Trustee members.

Continued links with the pre-service educators

The teachers in this study expressed the desire to have continued contact with lecturers from their pre-service institute, in specific curriculum areas in particular. Further research could investigate ways in which the providers of pre-service education can liaise with schools to share in the enrichment of the first year experience for beginning teachers.

Looking beyond the mathematics-focused teachers

How is it for first year teachers who, as pre-service students, did not choose to follow mathematics education courses beyond the compulsory stage? Would a similar reflective structure provided for first year teachers for whom mathematics is not a strength be empowering for them and enable them to function beyond the survival mode?.

Constructivism and assessment

Although there exist exemplars of both national and international efforts to assess the activity of open-ended mathematical tasks, research is needed within New Zealand to develop and publish, valid and reliable assessment procedures based on sound criteria, and in keeping with the constructivist framework of the New Zealand mathematics curriculum.

Constructivism and gender

Research is needed to ascertain the effects of constructivist expectations on girls in particular. Is the increasing emphasis on the provision of mathematics programmes which rely on overt participation and experimentation proving to be enabling, or disenabling, for girls when research indicates that girls are more fearful of risktaking than boys?

The male teacher perspective

In considering the gender-sensitive nature of his classroom, what issues arise for the male teacher? Are the personal memories of their own school mathematics different for men? To what extent do these experiences affect the beliefs about teaching girls and boys? Would a case study of a male primary teacher follow a similar path to the findings of the current study?

Socialisation over time

An individual case study is needed to ascertain whether there are any changes in teacher attitude, intention and performance over *time*. Research of this type might reveal how one particular aspect of this study explored over say the first, second and fifth year of teaching could change, or strengthen, with experience.

Finally, implications arise from the methodology itself. The nature of this study models a set of procedures for a qualitative method which could be used for further classroom research.

6.3 CONCLUDING STATEMENT

In summary, this study has intensified the questions: How can a teacher's beliefs help her to provide a safe learning environment for all the children, both girls and boys, particularly during the first year of teaching? To what extent do the influences of these beliefs, together with the requirements of the curriculum and the expectations of the school environment, support or hinder a teacher in her intentions to provide this safe environment?

For there seems to be no doubt that the teachers in this study were beyond merely surviving in the classroom and school: they were intent on achieving excellence. In terms of the framework of this research study that implies excellence in their efforts to provide equitable access to the learning all children, regardless of gender, within a mathematics programme based on constructivist principles.

REFERENCES

Adey, P., & Shayer, M. (1994). *Really raising standards: Cognitive intervention and academic achievement.* London: Routledge.

Ahmed, A. (1987). *Better mathematics: A curriculum development study.* London: Her Majesty's Stationery Office.

d'Ambrosio, U. (1990). The role of mathematics education in building a democratic and just society. *For the Learning of Mathematics, 10* (3), 20 - 23.

Atweh, B., & Cooper, T. (1995). The construction of gender, social class and mathematics in the classroom. *Educational Studies in Mathematics, 28* (3), 293 - 310.

Barnes, M. (1992, July). *Gender differences in the mathematics: Results from the NSW Basic Skills Tests.* Paper presented at the fifteenth annual conference of the Mathematics Education Research Group of Australasia, University of Western Sydney, Richmond, Australia.

Barnes, M. & Coupland, M. (1990). Humanizing calculus: A case study in curriculum development. In L. Burton (Ed.), *Gender and mathematics: An international perspective* (pp. 72 - 80). London: Cassell Educational.

Barton, B. (1993). Contemplating cultural contexts. In B. Atweh, C. Kanes, M. Carss, & G. Booker (Eds.), *Proceedings of the sixteenth annual conference of the Mathematics Education Research Group of Australasia. Contexts in mathematics education* (pp. 1 - 3). Brisbane: Mathematics Education Group of Australasia.

Begg, A. (1991). Assessment and constructivism. *New Zealand Mathematics Magazine, 28* (2), 14 - 20.

Begg, A. (1995a, August). *Constructivism in the classroom.* Paper presented at the fourth biennial conference of the New Zealand Association of Mathematics Teachers, Auckland, New Zealand.

Begg, A. (1995b). The mathematics curriculum: A comparative study. In A. Jones et al. (Eds.), *SAME papers 1995.* Hamilton, NZ: Centre for Science and Mathematics Education Research, University of Waikato

Bell, B. (1993, December). *Using anecdotes in teacher development.* Paper presented at the annual conference of the New Zealand Association for Research in Education, Hamilton, New Zealand.

Bennison, A., Wilkinson, L. C., Fennema, E., Masemann, V., & Peterson, P. (1984). Equity or equality: What shall it be? In E. Fennema, & M. J. Ayers, (Eds.), *Women and education* (pp. 1 - 17). Berkeley CA: McCutchan Publishing Corporation.

Bird, M. (1992). On removing the ceilings from young children's number work. *Mathematics in School, 21* (5), 8 - 15.

Bishop, A. J. (1993). Conceptualising cultural and social contexts in mathematics education. In B. Atweh, C. Kanes, M. Carss, & G. Booker (Eds.), *Proceedings of the sixteenth annual conference of the Mathematics Education Research Group of Australasia. Contexts in mathematics education* (pp. 5 - 10). Brisbane: Mathematics Education Group of Australasia.

Bishop, F., & Clements. M. A. (Ken). (1994). Predictions of gender differences in performances of years 5 and 6 children on pencil-and-paper mathematics items. In G. Bell, B. Wright, N. Leeson, & J. Geake (Eds.), *Proceedings of the seventeenth annual conference of the Mathematics Education Research Group of Australasia. Challenges in mathematics education: Constraints on construction* (pp. 105 - 112). Lismore, NSW: Mathematics Education Group of Australasia.

Blithe, T., & Clark, M. (1995). Choice, success, and context in questions in University Statistics examination for male and female students in New Zealand. In B. Grevholm & G. Hanna (Eds.), *Gender and mathematics education. An ICMI study* (pp. 89 - 99). Lund: Lund University Press.

Blithe, T., Clark, M., Forbes, S., & Forbes, R. (1994). *The testing of girls in mathematics. A Report for Women's suffrage: Whakatu wahine.* Wellington: Equity in Mathematics Education Collective.

Borg, W. R., Gall, J. P., & Gall, M. D. (1993). *Applying educational research: A practical guide* (Third Edition). New York: Longman.

Borko, H., Brown, C., Underhill, R., Eisenhart, M., Jones, D., & Agard, P. (1990). *Learning to teach mathematics (Year 2 Progress Report submitted to the National Science Foundation).* Blacksburg, VA: Virginia Polytechnic Institute and State University.

Britt, M. (1995, October). Conversation on the establishment of current mathematics education courses at Auckland College of Education.

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Britt, M., Irwin, K., Ellis, J., & Ritchie, G. (1993). *Teachers raising achievement in mathematics.* A Report to the Research Division of the Ministry of Education. Auckland: Centre for Mathematics Education, Auckland College of Education.

Brown, C., & Borko, H. (1992). Becoming a mathematics teacher. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 209 - 239). New York: Macmillan.

Burton, L. (1995). Moving towards a feminist epistemology of mathematics. *Educational Studies in Mathematics, 28* (3), 275 - 291.

Buzeika, A. (1995). Teachers' beliefs and practice: The chicken or the egg? In B. Barton (Ed.), *Mathematics education in change* (pp 127 - 135). Auckland: Mathematics Education Unit, University of Auckland.

Carpenter, T. P. and Fennema, E. (1991). Research and cognitively guided instruction. In E. Fennema, T. P. Carpenter, & S. J. Lamon (Eds.), *Integrated research on teaching and learning mathematics* (pp. 3 - 16). New York: State University of New York Press.

Carr, K. & Ritchie, G. (1991). Evaluating learning in mathematics. *SET, 1* (Item 15), 1 - 4.

Clark, C. M., & Peterson, P. L. (1986). Teachers' thought processes. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 255 - 296). New York: Macmillan.

Clark, M. (1994). Dismantling myths and barriers. *Victoria Quarterly, Winter,* 10 - 13.

Clarke, D. (1995, July). Constructive assessment: Mathematics and the student. In A. Richards (Ed.), *Proceedings of the fifteenth biennial conference of the Australian Association of Mathematics Teachers. Forging links and integrating resources* (pp. 72 - 81). Adelaide: The Australian Association of Mathematics Teachers.

Cobb, P., Yackel, E., & Wood, T. (1991). Curriculum and teacher development: Psychological and anthropological perspectives. In E. Fennema, T. P. Carpenter, & S. J. Lamon (Eds.), *Integrating research on teaching and learning mathematics* (pp. 83 - 119). New York: State University of New York Press.

Cochran, K . F., DeRuiter, J. A., & King, R. A. (1993). Pedagogical content knowledge: An integrative model for teacher preparation. *Journal of Teacher Education, 44* (4), 263 - 272.

Condon, M. W. F., Clyde, J. A., Kyle, D. W., & Hovda, R. A. (1993). A constructivist basis for teaching and teacher education: A framework for program development and research on graduates. *Journal of Teacher Education, 44* (4), 273 - 278.

Confrey, J. (1991). Learning to listen: A student's understanding of powers of ten. In E. von Glasersfeld (Ed.), *Radical constructivism in mathematics education* (pp. 111 - 138). The Netherlands: Kluwer Academic Publishers.

Education Review Office. (1995). Barriers to learning. *National Education Evaluation Reports, 9.* Wellington, New Zealand.

Ernest, P. (1992, July). *Varieties of constructivism: Their metaphors, epistemologies and implications for mathematics education.* Paper presented at the seventh International Congress on Mathematical Education, Quebec, Canada.

Fennema, E. (1990a). Teachers' beliefs and gender differences in mathematics. In E. Fennema, & G. C. Leder (Eds.), *Mathematics and gender: Influences on teachers and students* (pp. 169 - 187). New York: Teachers College Press.

Fennema, E. (1990b). Justice, equity, and mathematics education. In E. Fennema, & G. C. Leder (Eds.), *Mathematics and gender: Influences on teachers and students* (pp. 1 - 9). New York: Teachers College Press.

Fennema, E. (1993, October). *Mathematics, gender and research.* Paper presented at the International Commission on Mathematics Instruction Study: Gender and Mathematics Education, Hoor, Sweden.

Fennema, E., & Franke, M. L. (1992). Teachers' knowledge and its impact. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 147 - 164). New York: Macmillan.

Fennema, E., & Tartre, L. A. (1985). The use of spatial visualization in mathematics by girls and boys. *Journal for Research in Mathematics Education, 16* (3), 184 - 206.

Forbes, S. (1988). Gender differences in performance in the 1986 Mathematics with Statistics Scholarship examination. *New Zealand Statistician, 23* (1), 17 - 25.

Ford, M. (1994). Teachers' beliefs about mathematical problem-solving in the elementary school. *School Science and Mathematics, 94* (6), 314 - 322.

Forgasz, H. J. (1995). Gender and the relationship between affective beliefs and perceptions of grade 7 mathematics classroom learning environments. *Educational Studies in Mathematics, 28* (3), 219 - 239.

Fullerton, S. (1993). Confidence in mathematics: The effects of gender. *Research Monograph 2*. Deakin University: National Centre for Research and Development in Mathematics Education.

Goodman, J. (1988). The political tactics and teaching strategies of reflective, active pre-service teachers. *The Elementary School Journal, 89* (1), 23 - 41.

Grouws, D. A. (1991). Improving research in mathematics classroom instruction. In E. Fennema, T. P. Carpenter, & S. J. Lamon (Eds.), *Integrating research on teaching and learning* (pp. 199 - 216). New York: State University of New York Press.

Hagg, G. (1991). Constructivism: The path for maths in the 90's. *New Zealand Mathematics Magazine, 28* (2) 5 -13.

Hanna, G. (1994). Should girls and boys be taught differently? In R. Biehler, R. Scholtz, R. Strasser, & B. Winkelmann (Eds.), *Didactics of mathematics as a scientific discipline* (pp. 303 - 316). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Hart, L. E. (1989). Classroom processes, sex of student, and confidence in learning mathematics. *Journal for Research in Mathematics Education, 20* (3), 242 - 260.

Haynes, M. (1994, December). *Gender equity in society and in mathematics education in New Zealand.* Paper presented at the annual conference of the New Zealand Association for Research in Education, Christchurch, New Zealand.

Hollingsworth, S. (1989). Prior beliefs and cognitive change in learning to teach. *American Educational Research Journal, 26* (2), 160 - 189.

Howson, G. (1995). *Mathematics in the New Zealand Curriculum.* A Review for the Education Forum.

Hoy, W. (1968). The influences of experience on the beginning teacher. *Journal of Educational Research, 66,* 89 - 93.

Huber, G., & Marcelo Garcia, C. (1993). Voices of beginning teachers: Computer-assisted listening to their common experiences. In M. Schratz (Ed.), *Qualitative voices in educational research* (pp. 139 - 156). London: Falmer Press.

Inkpen, K., Klawe, M., Lawry, J., Sedighian, K., Leroux, S., Hsu, D., Upitis, R., Anderson, A., & Ndunda, M. (1994). "We have never-forgetful flowers in our garden": Girls' responses to electronic games. *Journal of Computers in Mathematics and Science Teaching, 13* (4), 383 - 403.

Isaacson, Z. (1988). The marginalisation of girls in mathematics: Some causes and some remedies. In D. Pimm, (Ed.), *Mathematics, teachers and children* (pp. 95 - 108). Norwich: Hodder & Stoughton in association with the Open University.

Jacobs, J. E., & Wigfield, A. (1989) Sex equity in mathematics and science education: Research-policy links. *Educational Psychology Review, 1* (1), 39 - 56.

Jones, D. (1995). Making the transition: Tensions in becoming a better mathematics teacher. *The New Zealand Mathematics Magazine, 32* (2), 1 - 7.

Jones, L. & Smart, T. (1995). The confidence factor: Intervention strategies designed to encourage positive attitudes to mathematics. In B. Grevholm, & G. Hanna (Eds.), *Gender and mathematics education. An ICMI study* (pp. 223 - 232). Lund: Lund University Press.

Joyce, B., & Clift, R. (1984). The Phoenix agenda: Essential reform in teacher education. *Educational Researcher, 13* (4), 5 - 18.

Keiny, S. (1994). Constructivism and teachers' professional development. *Teaching and Teacher Education, 10,* 157 - 167.

Kelly, A. (1984). Why girls don't do science. In A. Kelly (Ed.), *Science for girls?* (pp. 12 - 17). Milton Keynes: Open University Press.

Koehler, M. S., & Grouws, D. A. (1992). Mathematics teaching practices and their effects. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 115 - 126). New York: Macmillan.

Kreinberg, N. (1989). The practice of equity. *Peabody Journal of Education, 66* (2), 127 - 146.

Kuzmic, J. (1994). A beginning teacher's search for meaning: Teacher socialization, organizational literacy, and empowerment. *Teaching and Teacher Education, 10* (1), 15 - 27.

Lacey, C. (1977). *The socialization of teachers.* London: Methuen.

Lajoie, S. (1992). A framework for authentic assessment in mathematics. *National Center for Research in Mathematical Sciences Education Research Review, 1* (1), 6 - 12.

Lakatos, I. (1976). *Proofs and refutations.* Cambridge: Cambridge University Press.

Lampert, M. (1991). Connecting mathematical teaching and learning. In E. Fennema, T. P. Carpenter, & S. J. Lamon (Eds.), *Integrating research on teaching and learning mathematics* (pp. 121 - 152). New York: State University of New York Press.

Laurenson, D. (1995, April). *Mathematics and the drift towards constructivism: Are teacher beliefs and teaching practices following similar paths?* Paper presented at a meeting of the Mathematics Education Unit, University of Auckland, New Zealand.

Leder, G. C. (1990). Teacher/student interactions in the mathematics classroom: A different perspective. In E. Fennema, & G. C. Leder (Eds.), *Mathematics and gender: Influences on teachers and students* (pp. 149 - 168). New York: Teachers College Press.

Leder, G. (1993). Constructivism: Theory for practice? The case of mathematics. *Higher Education Research and Development, 12* (1), 5 - 20.

Leder, G. (Ed.). (1995). *Educational Studies in Mathematics, 28* (3).

Lerman, S. (1994). Reflective practice. In B. Jaworski, & A. Watson (Eds.), *Mentoring in mathematics education* (pp. 52 - 64). London: The Falmer Press.

Ligana, J. (1970). *What happens to the attitudes of beginning teachers?* Danville IL: Institute Printers.

Lortie, D. C. (1975). *School -teacher: A sociological study.* Chicago: University of Chicago Press.

Maher, C. A. & Davis, R. B. (1990). Teacher's learning: Building representations of children's meanings. In R. Davis, C. A. Maher, & N. Noddings (Eds.), *Constructivist views on the teaching and learning of mathematics. Journal for Research in Mathematics Education Monograph, 4.* (pp. 79 - 90). Reeston, VA: National Council of Teachers of Mathematics.

Mayers, C. (1994). *Mathematics and mathematics teaching: Changes in pre-service student-teachers' beliefs and attitudes.* Unpublished master's thesis, University of Auckland, Auckland, New Zealand.

Mayers, C., & Britt, M. (1995). Constructivism in the mathematics classroom. In J. Neyland (Ed.), *Mathematics education: A handbook for teachers, Vol 2* (pp. 60 - 69). Wellington: The Wellington College of Education.

Mayo, E. (1994). On power and equity: Let's not blame the victim. In J. Neyland (Ed.), *Mathematics education: A handbook for teachers, Vol 1* (pp. 291 - 306). Wellington: The Wellington College of Education.

McIntosh, E. (1950). The concise Oxford dictionary (4th edition reprinted 1956). London: Oxford University Press.

Meade, A., & Staden, F. (1985). Once upon a time, amongst blocks and car cases...... *SET 2* (Item 5), 1 - 30.

Ministry of Education. (1992). *Mathematics in the New Zealand curriculum.* Wellington: Learning Media.

Morton, M. J., Pemberton, J. R., Reilly, B. J., Reilly, I. L., & Lee, A. J. (1988). Is the gender gap in Bursaries Mathematics with Calculus narrowing? *New Zealand Mathematics Magazine, 25* (4), 3 - 21.

Mousley, J. (1992). Research in practice: Teachers as researchers. In B. Atweh, & J. Watson (Eds.), *Research in mathematics education in Australasia 1988 - 1991* (pp. 96 - 114). Brisbane: Mathematics Education Research Group of Australasia.

Mousley, J. (1993). Constructivism: A new way of teaching mathematics? In J. Mousley, & M. Rice (Eds.), *Mathematics: Of primary importance* (pp. 326 - 334). Victoria: Mathematical Association of Victoria.

National Council of Teachers of Mathematics. (1990). *Professional Standards for Teaching Mathematics.* Reston, VA: Author.

Neyland, J. (1994). Problems with proposed Unit Standard framework for mathematics. *New Zealand Mathematics Magazine, 31* (1), 1 - 9.

Neyland, J. (1995). Neo-behaviourism and social constructivism in mathematics education. In A. Jones et al. (Eds.), *SAMEpapers 1995*, Hamilton, NZ: Centre for Science and Mathematics Education research, University of Waikato.

Niesser, U. (1967). *Cognitive psychology.* New York: Appleton-Century-Croffts.

Noddings, N. (1990). Constructivism in mathematics education. In R. Davis, C. Maher, & N. Noddings (Eds.),*Constructivist views on the teaching and learning of mathematics* . *Journal for Research in Mathematics Education Monograph, 4.* (pp. 7 - 18). Reston, VA: National Council of Teachers of Mathematics.

Pateman, N. (1989). Research into practice: Teachers researching their mathematics classrooms. *Arithmetic Teacher, 37* (2), 36 - 38.

Perry, W. (1970). *Forms of Intellectual and Ethical Development in the College Years.* New York: Holt, Rinehart and Winston.

Piaget, J. (1965). *Judgement and reasoning in the child* (4th edition). London: Routledge & Kegan Paul.

Pollina, A. (1995). Gender balance: Lessons from girls in science and mathematics. *Educational Leadership , 53* (1), 30 - 33.

Pultorak, E. G. (1993). Facilitating reflective thought in novice teachers. *Journal of Teacher Education, 44* (4), 288 - 295.

Regan, H. B., & Hannah, B. H. (1993). Ten teachers teaching: The interplay of individuals, their preparation and their schools. *Journal of Teacher Education, 44* (4), 305 - 311.

Reilly, B. J., Reilly, I. L., Pemberton, J. R., & Lee, A. J. (1987). Gender differences in performances in Bursaries Pure Mathematics. *New Zealand Mathematics Magazine, 24* (1), 19 - 33.

Renwick, M., & Vize, J. (1993). *Windows on teacher education: The final report.* Wellington: New Zealand Council for Educational Research and Ministry of Education.

Romberg, T. (1993). How one comes to know: Models and theories of the learning of mathematics. In M. Niss (Ed.), *Investigations into assessment in mathematics education. An ICMI Study* (pp. 97 - 111). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Romberg, T. A., & Carpenter, T. P. (1986). Research on teaching and learning mathematics: Two disciplines of scientific enquiry. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 850 - 873). New York: Macmillan.

Rose, D. (1993, December). *Do teachers use skills which they have been trained to use?* Paper presented at the annual conference of the New Zealand Association for Research in Education, Hamilton, New Zealand.

Rowe, K. (1990). What are the benefits of single-sex maths classes? *SET 1* (Item 9), 1 - 4.

Rust, F. O'C. (1994). The first year of teaching: It's not what they expected. *Teaching and Teacher Education, 10* (2), 205 - 217.

Shiu, C. (1995, August). *Task and talk in mathematics classrooms.* Plenary presentation at the fourth biennial conference of the New Zealand Association of Mathematics Teachers, Auckland, New Zealand.

Shuard, H. (1983). The relative attainment of girls and boys in mathematics in the primary years. In L. Burton (Ed.), *Girls into maths can go* (pp. 22 - 37). London: Holt, Rinehart & Winston.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57* (1), 1 - 22.

Simon, M. A. & Schifter, D. (1991). Towards a constructivist perspective: An intervention study of mathematics teacher development. *Educational Studies in Mathematics, 22,* 309 - 331.

Smail, B. (1984). Girl-friendly science. In A. Kelly (Ed.), *Science for girls?* (pp. 80 - 88). Milton Keynes: Open University Press.

Solar, C. (1992). 'Dentelle de pedagogies feministes'. *Revue canadienne de l'education / Canadian Journal of Education, 17* (3), 264 - 285.

Solar, C. (1995). An inclusive pedagogy in mathematics education. *Educational Studies in Mathematics, 28* (3), 311 - 333.

Stanic, G. (1989). Teachers researching their own mathematics classroms. *Arithmetic Teacher, 37* (2), 36 - 38.

Steffe, L. (1990). Mathematics curriculum design: A constructivist's perspective. In L. P. Steffe, T. Wood (Eds.), *Transforming students' mathematical education: International perspectives.* (pp. 389 - 398). Hillsdale, NJ: Lawrence Erlbaum Associates.

Steffe, L. & Kieren, T. (1994). Radical constructivism and mathematics education. *Journal for Research in Mathematics Education, 25* (6), 711 - 733.

Sullivan, P. & Leder, G. C. (1992). Students' influence on novice teachers' thoughts and actions regarding mathematics teaching: Two case studies. *The Elementary School Journal, 92* (5), 621 - 642.

Sutton, R. (1995). *Assessment for learning.* Salford, U.K.: RS Publications.

Taole, J. K., Zonneveld, M. & Letsie-Taole, L. (1995). Gender interaction in mathematics classrooms: Reflection and transformation. *Educational Studies in Mathematics, 28* (3), 263 - 274.

Thompson, A. G. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 127 - 146). New York: Macmillan.

Turner, R. (1994, July). Sex differences in mathematical performance among Chinese middle school students. In G. Bell, B. Wright, N. Leeson, & J. Geake (Eds.), *Proceedings of the seventeenth annual conference of the Mathematics Education Research Group of Australasia. Challenges in mathematics education: Constraints on construction* (pp 649 - 666). Lismore, NSW: Mathematics Education Group of Australasia.

Underhill, R. G. (1988). Focus on research into practice in diagnostic and prescriptive mathematics. Mathematics teachers' beliefs: Review and reflection. *Focus on Learning Problems in Mathematics, 10* (3), 43 - 58.

Van Manen, M. (1977). Linking ways of knowing with ways of being practical. *Curriculum Inquiry, 6,* 205 - 228.

Veenman, S. (1984). Perceived problems of beginning teachers. *Review of Educational Research 54* (2), 143 - 178.

Verhage, H. (1990). Curriculum development and gender. In L. Burton (Ed.), *Gender and mathematics: An international perspective* (pp. 60 - 71). London: Cassell Educational.

von Glasersfeld, E. (1989). Constructivism in education. In T. Husen, & T. N. Postlethwaite (Eds.), *The international encyclopaedia of education Supplementary volume 1* (pp. 162 - 163). New York: Pergamon Press.

von Glasersfeld, E. (1990a). Environment and communication. In L. P. Steffe, & T. Wood (Eds.), *Transforming children's mathematics education: International perspectives* (pp. 30 - 38). Hillsdale, NJ: Lawrence Erlbaum Associates.

von Glasersfeld, E. (1990b). An exposition of constructivism: Why some like it radical. In R. Davis, C. Maher, & N. Noddings (Eds.),*Constructivist views on the teaching and learning of mathematics . Journal for Research in Mathematics Education Monograph, 4* (pp. 19 - 30). Reston, VA: National Council of Teachers of Mathematics.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds. and Trans.). Cambridge MA: Harvard University Press.

Walshaw, M. (1994). *The implementation of Mathematics in the New Zealand Curriculum.* Research Affiliateship Scheme Report No. 7. Unpublished dissertation, Massey University, Palmerston North, New Zealand.

Willis, S. (1989). *Real girls don't do maths: Gender and the construction of privilege.* Geelong, Victoria: Deakin University Press.

Willis, S. (1992, August). *Theoretical models for addressing gender differences in mathematics.* Panel presentation at the meeting of the International Organisation of Women and Mathematics Education held at the Seventh International Congress on Mathematical Education, Quebec.

Wright, B., & Tuska, S. (1968). From dream to life in the psychology of becoming a teacher. *School Review, 75,* 123 - 154.

Yackel, E., Cobb, P., Wood, T., & Merkel, G. (1990). Experience, problem-solving, and discourse as central aspects of constructivism. *Arithmetic Teacher, 38* (4), 34 - 35.

Young-Loveridge, J. (1991). *Gender differences in number knowledge: A longitudinal study of children aged five to nine.* Paper presented at the second biennial conference of the New Zealand Association of Mathematics Teachers, Wellington, New Zealand.

Zeichner, K .M., & Tabachnick, B. R. (1988). The development of teacher perspectives: Social strategies and institutional control in the socialization of beginning teachers. *Journal of Education for Teaching, 11* (1), 1 - 25.

Zevenbergen, R. (1993a). Learning mathematics: A gendered practice. In B. Atweh, C. Kanes, M. Carss, & G. Booker (Eds.), *Proceedings of the sixteenth annual conference of the Mathematics Education Research Group of Australasia. Contexts in mathematics education* (pp. 603 - 611). Brisbane: Mathematics Education Group of Australasia.

Zevenbergen, R. (1993b). The production of gendered positions in mathematics. In J. Mousley, & M. Rice (Eds.), *Mathematics: Of primary importance* (pp. 326 - 334). Victoria: Mathematical Association of Victoria.

APPENDICES

CONTENTS

APPENDIX 1   INFORMATION AND CONSENT FORMS

a)   Information Sheet for Participants

b)   Consent Form for Participants

c)   Information Sheet for Boards of Trustees

d)   Consent Form for Boards of Trustees

e)   Information Sheet for Caregivers

a)   Information Sheet for Participants

Purpose
There is a growing body of literature which suggests that the behaviour practised by beginning teachers in the classroom is inconsistent with the beliefs and skills developed during their pre-service education. As the research study towards my Master of Educational Studies (Mathematics) I am interested in investigating whether first year teachers are able to put into practice the beliefs and behaviours that they formulate during final year courses in their pre-service education. My intention is to follow-up a group of teachers during their first year of teaching in primary classrooms and to explore their practices within the context of gender equity in mathematics learning and teaching.

Procedure
Data collected from these teachers during their final pre-service year at Auckland College of Education indicates their beliefs about issues of gender equity within the mathematics classroom. I intend to meet with the group of teachers to identify relevant issues within the above context which will become the key issues for the study. The teachers will be asked to keep a diary relating to these issues and I will meet with each person individually to follow-up on details of the diary. The follow-up will include a series of observations and interviews related to goals set collaboratively by the teacher and myself.

It is hoped that the collaborative involvement of the teachers in the study will lead to a level of self-development within the context of gender equity in the teaching of primary mathematics. Each teacher will be given access to the findings from the study as it develops and will receive a summary at its conclusion.

Outline

May 1995	Group meeting
June 1995	Completion of diary
June-August 1995	Observations/interviews

Participation

I would really appreciate your cooperation in helping me with this study and I am pleased to invite you to be a participant. This would be on the understanding that you would be able to withdraw from the study and be free to withdraw any information you would have previously contributed to the study, without explanation at any time. You would have the right to refuse to answer any particular question and to ask any further questions that occur to you during your participation.

You have my assurance that none of this information will be made available to anyone except as anonymous data in my study. This includes personnel both at the school where you are teaching position and at Auckland College of Education.

If you have any queries you may contact me at
- Auckland College of Education College ███████████

or my supervisor Associate Professor Gordon Knight at
- Massey University, Albany Campus ████████

Thank you for your cooperation

b) Consent Form for Participants

I have read the Information Sheet for this study and have had the details of the study explained to me. My questions about the study have been answered to my satisfaction and I understand that I may ask further questions at any time.

I also understand that I am free to withdraw from the study at any time, or to decline to answer any particular questions in the study. I agree to provide information to the researcher on the understanding that it is completely confidential.

I wish to participate in this study under the conditions set out on the Information Sheet.

Signed: ....

Name: ....

Date: ....

c) Information Sheet for Board of Trustees

Purpose

There is a growing body of literature which suggests that the behaviour practised by beginning teachers in the classroom is inconsistent with the beliefs and skills developed during their pre-service education. As the research study towards my Master of Educational Studies (Mathematics) I am interested in investigating whether first year teachers are able to put into practice the beliefs and behaviours that they formulate during final year courses in their pre-service education. My intention is to follow-up a group of teachers during their first year of teaching in primary classrooms and to explore their practices within the context of gender equity in mathematics learning and teaching.

Procedure

Data collected from these teachers during their final pre-service year at Auckland College of Education indicates their beliefs about issues of gender equity within the mathematics classroom. I intend to meet with the group of teachers to identify relevant issues within the above context which will become the key issues for the study. The teachers will be asked to keep a diary relating to these issues and I will meet with each person individually to follow-up on details of the diary. The follow-up will include a series of observations and interviews related to goals set collaboratively by the teacher and myself.

It is hoped that the collaborative involvement of the teachers in the study will lead to a level of self-development within the context of gender equity in the teaching of primary mathematics. Each teacher will be given access to the findings from the study as it develops and will receive a summary at its conclusion.

Participation

I would really appreciate your support with this study by allowing me to work within your school between June and August 1995. You have my assurance that none of this information will be made available to anyone except as anonymous data in my study. This includes personnel both at your school and at Auckland College of Education. A sample information sheet for caregivers is enclosed for your approval. It is intended that this be distributed to the caregivers of the children in the particular classroom involved in this study on

approval of the proposal. I would welcome any comments or amendments you feel appropriate.

The invited participants have more details of the study should you require further information. However if you have any queries you may contact me at
- Auckland College of Education College ███████████

or my supervisor Associate Professor Gordon Knight at
- Massey University, Albany Campus ████████

Thank you for your cooperation

d) **Consent Form for Board of Trustees**

We have read the Information Sheet for this study and we consent to the involvement of our school in the provision of information towards its findings.

We wish to participate in this study under the conditions set out on the Information Sheet.

Signed: ....

Name: ....

Date: ....

e)   Information Sheet for Caregivers

As the research study towards my Master of Educational Studies (Mathematics) I am interested in investigating whether first year teachers are able to put into practice the beliefs and behaviours that they formulate during final year courses at College of Education. My intention is to follow-up a group of teachers during their first year of teaching in primary classrooms and to explore their practices within the context of gender equity in mathematics learning and teaching. Despite living in a society which is now more sensitive to gender equity it is still a concern that girls and boys should receive the same opportunities to be involved in, and to enjoy, their mathematics.

In working with the group of teachers I shall be observing some mathematics sessions in your child's classroom between June and August 1995.. You have my assurance that none of this information will be made available to anyone except as anonymous data in my study. This includes personnel both at your school and at Auckland College of Education. If you have any questions regarding this study please feel free to contact me at Auckland College of Education ███████████████

Thank you for your cooperation

APPENDIX 2   PERSONAL INFORMATION

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a)   Teaching qualifications
b)   Background information

a) Teaching qualifications

	Highest level of mathematics	On graduation from college	Number of years at college	B.Ed. pending completion
Tracey	Stage 1 (univ)	B.A.(English) Dip. Teaching	Two	N/A
Emily	Form 5	Dip. Teaching	Three	yes
Claire	Form 5	Dip. Teaching	Three	yes
Julie	Stage 1 (univ)	Dip. Teaching	Four	no
Rachel	Form 7	Dip. Teaching	Four	yes
Kylie	Form 4	B. Ed. Dip. Teaching	Four	N/A

b) Background Information

General Information for Research Project by: Maggie Haynes - 1995

1   Year at College   2nd   ☐
                                                           3rd   ☐
                                                           4th   ☐

2   Age   ☐

3   Sex   Female   ☐
                                                   Male   ☐

4   Ethnicity   [＿＿＿＿]

5   Highest level of mathematics studied   Form 4   ☐
                                                           Form 5   ☐
                                                             Form 6   ☐
                                                             Form 7   ☐
                                                        Further   ☐

6   Number of years out from school   ☐

7   Number of mathematics education courses at ACE   ☐
      other than 625.100/200

8   Why have you chosen to take 625.301/6?

_____
_____
_____

9   Name   [＿＿＿＿＿＿＿＿＿＿]

APPENDIX 3   TIMELINE OF THE PROCESS

Stage	1	2	3	4	5
1995	May	June	July	July	August
	Group meeting	Completion of diary	Background information & goal setting	Observation & interview 1	Observation & interview 2

APPENDIX 4   KEY ISSUES FOR DIARIES

Children's dialogue/interaction

What sort of talk went on amongst the children today?

Questioning, both teacher and children

How did today's questioning affect the learning of each individual?

Assessment and reporting

To what extent am I aware of the achievements of the children today?

Response to behaviour

To what extent did my classroom management affect the learning?

Meaningful Context

How did my materials/texts encourage the participation of all the children?

Provision/use of equipment

How was the classroom equipment used today?

Learning styles

What sort of learning took place today?

Constructivism

To what extent did today's tasks encourage the children to use their own problem-solving strategies?

APPENDIX 5   FOUNDATION FOR INTERVIEWS

a)   Interview 1 (Stage 3)

b)   Interview 2 (Stage 4)

c)   Interview 3 (Stage 5)

d)   Grid for observation in terms of constructivism

a) Interview 1

1. Tell me about your school
2. Tell me about your class
3. Let's talk through your diary responses
4. How do you provide for the children to have equitable access to the learning?
5. What would you say was the most useful aspect of your mathematics education at college?
6. What does constructivism mean to you?
7. What specific issue would you like to focus on as your goal?

b) Interview 2

Constructivism

1. Mark where would you see yourself on this continuum in terms of your beliefs about your teaching of mathematics?

1_____ 10
  traditionalist   constructivist

2. Tell me your reasons for positioning yourself there

3. Can you give me any instances in today's lesson of you as a constructivist?

4. What were the implications of today's lesson for your girls and your boys?

5. Are there any changes you might make? Why/why not?

6. Looking at my observation sheet, how does it compare with your reflection?

Goal

1. What strategies did you plan/implement today to provide equitable access to the learning?

2. How does this relate to my observation of your goal?

3. Do you have any further comment on equity within your classroom?

Content knowledge

1. On this continuum mark where you would rate your own content knowledge of mathematics

   _____
   low   high

2. Can you comment on this?

3. What do you think about the need for content knowledge?

Goal (cont.)

How would you like to develop your goal for the next observation visit?

c) Interview 3

Goal

1. Could we talk through your lesson in terms of your goal?

2. What strategies did you plan in order to achieve your goal?

Influences

• prior to pre-service teacher education

1. What made you apply to college?

2. Tell me about your mathematics experiences before college?

• during pre-service teacher education

3. What did you gain from college in terms of strategies for effective teaching?

4. Why did you apply for a position at this school?

• during your first semester as a teacher?

5. What does the school provide to support you during this first year?

6. Are there any other support mechanisms you use?

d) Constructivism Observation

TEACHER ....

Telling	Asking
Paraphrasing	Requesting paraphrasing/elaboration
Commenting on correctness	Encouraging the exploration of misconceptions
Product	Process
Imposing mathematical ideas	Helping to form bridges between own/mathematical ideas

APPENDIX 6   TEACHER PROFILES

a)   Claire

b)   Emily

c)   Julie

d)   Kylie

e)   Rachel

f)   Tracey

The story of Claire

Claire teaches in a small semi-rural school situated three-quarters of an hour's drive from a large city. The children come from a variety of family backgrounds, mainly European and Maori, and attend the school with varying degrees of regularity. Some live on large farms which have been in their families for many years, while others live on newer small-holdings. The changing roll is due mostly to the movement of some families between the marae and the city, depending on their employment situation. The children in this junior class are six and seven years old.

Claire had left school 25 years earlier and begun raising a family immediately. During this period of full-time parenting she developed an interest in how children learn through participating in the supervisor-training programme for parents within the Playcentre movement. She continued to gradually lift her self-esteem by successfully completing university papers through distance education. She had always planned to become a teacher and at an appropriate time in her family's growth she entered a College of Education. One of her aims was to provide in the classroom the same free-flowing environment as the play environment she had believed in for her children's early childhood experiences.

At school Claire had been denied the opportunity to follow the School Certificate mathematics course and despite personal efforts, to nevertheless sit the examination, she was not successful. This experience of school mathematics had left Claire with a low self-image. During her years at college she continued to have concerns about her own level of achievement in mathematics but she was also determined that this would not prevent her from teaching mathematics within her belief framework of constructivism. The strength of Claire's philosophy did in fact enable her to be a successful

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participant in her mathematics-education courses and she began teaching confident that she would be able to involve the children and their contributions as an integral part of her mathematics teaching.

The story of Emily

Emily teaches a class of seven year olds in a suburban city school. The school population consists of predominantly Pacific Island families of whom seventy percent are Samoan. The children in Emily's class have very little formal early childhood education, most of their pre-school experiences come from activities within their extended families.

Emily's first direction after school prepared her for an occupation which did not provide her with much interpersonal interaction and she entered a College of Education bringing to teaching a real interest in people as individuals of worth. She highlights as a resource from her time there, the opportunity to gather experiences and information, both real and anecdotal, that might enhance her relationships with the children.

Although some unfortunate experiences in Emily's own school mathematics had led to her dropping mathematics sooner than she had anticipated, she recognises in herself, success in the cognitive processes involved in the satisfactory 'doing' of mathematics. This personal enjoyment of mathematics, together with her belief in a constructivist way of doing things, enriches her teaching of the subject. She continually strives to provide rich and enjoyable mathematics experiences for the children in her class.

The story of Julie

Julie teaches in a multicultural school in the suburbs of a large city. The school population is mainly Pacific Island and Maori. In Julie's class the majority of the children are Tongan and the other ethnicities are Samoan, Maori, European, Nuiean and Cook Island. The children often speak to each other in their own languages and Julie has to question whether difficulties which might arise in mathematics are as a result of a language or mathematics barrier.

Julie entered a College of Education after two years in the workforce. She had completed University Bursary mathematics courses at school and her own school experiences in mathematics were very positive. At secondary school she had been encouraged to think for herself and to make decisions based on her findings. She remembers the mathematics classroom as an environment where risk-taking was encouraged.

Throughout her pre-service teacher education Julie felt comfortable with her choice of mathematics-education courses. Confidence in her own mathematics allowed Julie to focus on catering for the individual. In particular she took an interest in the effect of ethnicity, gender and preferred learning style on an individual's participation in mathematics learning. She began teaching with the intention of catering for all children by providing a variety of materials, contexts and resources in order to motivate as many children as possible at any one time.

The story of Kylie

Kylie teaches in a large urban multi-cultural school. Currently there are twenty seven ethnicities represented within the junior syndicate to which she belongs. Her own class contains children at varying stages of language development. Although the children's ages range from 5 to 7 years old, at this stage there is a larger proportion of younger children who begin school in Kylie's class and who will then stay with her the following year.

Kylie entered a College of Education from family life. She had left school thirty years previously and during the years spent in raising a family she had been closely involved in their early childhood education, within the Playcentre movement. It was through this involvement that Kylie became interested in education and during her time as a parent-helper at her children's primary schools it was suggested to her that she apply for entry to a College of Education

Kylie's own school mathematics experiences had left her with a real fear of mathematics of which she became fully aware only on entry to college. However in studies during her time at Playcentre she had developed a strong philosophy on how children learn and at college she discovered that these matched the current theories behind constructivism. Kylie's anxiety about mathematics remained with her during the first year at college but once she realised that the beliefs of constructivism extended to mathematics she gained confidence in the teaching of mathematics. Due to her own experiences Kylie began teaching with a determination to ensure that all children would have the opportunity to bring to their mathematics, their own knowledge and experiences and to feel empowered by their mathematics involvement.

The story of Rachel

Rachel teaches a class of Standard 3/4 children in a multicultural school in a city suburb. The school has a stable population, with some families choosing to send their children there from outside the school zone. The ethnic composition of her class is predominantly Samoan and Tongan, with a few Maori and European children. The children's ages range from 9-11 years.

Rachel entered a College of Education straight from school where she had completed Form 7 Mathematics. She was aware from Standard 3 onwards that she was 'good at maths', and as she had enjoyed her mathematics experiences at school, she retained positive memories of her own classroom experiences. Her focus during her time at college became that of how she could help other children to learn and enjoy mathematics

Through her mathematics-education courses Rachel learnt the value of not making assumptions about a child's level of understanding and developed strategies for focusing on children's understanding. She valued the opportunities to experience, for herself, mathematical tasks which catered for a variety of ability levels. She began her teaching with a strong belief in catering for the individual and taking into account the prior experiences and background of each child in her class. Despite her beliefs in constructivism, Rachel struggles in her practice, with her desire to provide a mathematics programme with an open-ended base and the satisfaction of recognising, from 'test' situations, that basic skills have been achieved.

The story of Tracey

Tracey teaches a junior class in a large urban multi-cultural school. The school is overcrowded with a transient population. For many children in her class English is a second language while, of the few for whom it is a first language, it is often a non-standard English due to the type of English spoken at home. Some children enter her class with very little language at all. The children's ages range from 5 to 7 years.

Tracey spent two years as a student teacher, having completed a university degree in English, with some Mathematics papers, before entering a College of Education. She had already set personal study goals which included taking out of the pre-service education course only what she felt fitted her philosophy. However, by observing those for whom other practices were relevant, she questioned and thence strengthened her own beliefs. She viewed teaching positively and was determined from the outset to 'do it my way'.

Having completed some papers in mathematics at university, Tracey was confident in her own mathematics and keen to "consolidate the concepts' at college in order to teach mathematics effectively. She already valued a child-centred approach and believed that the most important aspect of teaching for learning was a focus on the individual. While at college she developed a strong philosophy through her mathematics-education courses and began her teaching with a strong belief in a constructivist approach to the teaching and learning of mathematics.

APPENDIX 7   RESPONSES RELATING TO TABLE 2

The numbers relate to the references in Table 2 on Page 76.

Overt compliance
desiring to fit into the procedures of the school

No responses

Critical compliance
accepting the requirements of the school and teaching accordingly nevertheless being critical of the requirements

[1]Tracey: *... and then there's checklisting ... I do tick them all off and I've got 'processes' check lists, but again a check list, in itself, is to me behaviourist and doesn't do what I want it to do. I seem to spend my life writing them out. Next week, we have parent-teacher sessions and we don't do reports until the end of the year. I'll try to tell them something from my checklists. For measurement , for instance, in my reports I could write " 'so and so' can show that there are various unconventional ways of measuring distance" ... but you couldn't tell that from my checklist. Sometimes I have to spend a whole day, in everything, doing check lists and I don't really see a lot of point. It is meaningless really, compared with writing about one child every so often and what they do. As well as maths and reading, I check list for PE, and I check list for music, and I just check list everything I teach. I think this check-listing business is overdone, and I argue and argue about it ... with my team.*

[2]Julie: *I work with one group ... that's what my tutor teacher wants , and the rest of the children, they go to what the kids call choosing, we call it developmental, where they get maths equipment to use, and utilise, and work with, but it's not teacher directed. We're starting to put a*

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little bit more direction, asking questions ..."can you make this?" and giving them things to work from but ... it's mostly the kids always going to where they want to .... I have to concentrate on my group and the others ... they usually work on these two tables, work together as a group, not too much teacher direction.

[3]Rachel: *At first I was struggling, providing exercises for the children everyday, and it was really hard work. I was just tearing my hair out having to provide work all the time for them. I wasn't coping really well with it, so my teaching wasn't very good, and the follow up exercises weren't very good because I was having to provide all the time.*

[4]Kylie: *I find myself in a bit of difficulty because I have these things (objectives) that have to be met, and I have to not only do this, but I also have milestones that the children are expected to reach in school. I've got them for all areas of the curriculum ... they've been pulled out of the maths curriculum say, and I'm finding myself .... I mean I fight it, but teaching to these outcomes narrows down the thinking and experiences that the children have. It makes a mockery of assessment really ... assessment at this level should be about what a child is doing, not whether she can perform a pre-determined task or not. When you come to assess children ... and the narrowness of the assessment that we use ... those achievement objectives don't tell me anything. Oh, I can demonstrate what I need to, ticking the things on those checklists, and those children will do it for me, well most of them. But that doesn't mean to say that they have learnt that particular concept, or they can do that independently, or they have*

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explored the idea and they have made graphs ... it doesn't mean that at all.

5Emily: *I have this checklisting to do ... and quite honestly, for the rest of them ... unless they are doing something that grabs my attention, then I can't take much notice until they come back down with me again. I'll prescribe activities for the children, like what we might be doing, but I really can't tell you what they might be doing or how they are using the stuff.*

6Claire: *What comes through all the time to me is that you need to keep your own ideals, even you know ... your own ideas about learning. Maybe they have to adjust but they don't change ... you adjust them to fit in. I always wondered how I'd ever fit into a normal classroom because of my ideas on how children learn and I thought "Now, how am I going to do this and still fit in with what a school might want?" I've got a tutor teacher who's quite formal and she often says to me "You know you are not strict enough on the kids, ... the kids should be quieter, the kids should sit still", and I still don't do it because it's not me. So when I do a lesson in front of her, yes, I would be harder on the kids. Probably make them sit and be quiet more because that's what she's expecting of me. And she watches and she writes it down and, sort of, gives me suggestions on how to make them quieter and so on. Well, you've got to, but it's still not me, I know it's not me. I like the interaction with the children and the fact that they are free to actually use their own initiative.*

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Accommodative resistance

| reflecting on ways to resist and perhaps alter existing procedures |

[1]Tracey: *As well as the equipment I'm supposed to use, because I'm not comfortable with this teaching to ability groups, I try to spend just minimum time on this and then let them try it in other ways. I do my teaching groups and they go off. My tutor teacher knows this because she's seen me do it .... I put out stations round the room. It's like say, just like a maths environment, because they always go for the same thing otherwise ... so I put out this other stuff.... I don't tell them exactly what they've got to do ... it's the best I can do for constructivism but I'm not saying "Here copy me" ... and that's when I do most of my best assessment, I let them go for it and I walk round the room observing them.*

[2]Julie: *Well you see ... the size of the class (variable space classroom) means that no way can I have the children talking as loud as I'd like ... I like a certain amount of noise level in maths but you've got to work with this other person ... and she's your tutor teacher too ... so I've got to think about what she wants too. But I've talked it over with her and I think she understands where I'm coming from, so we'll see.*

[3]Julie: *Those patterns on the wall ... that could have been a maths activity but it was just art, related to the centre of interest. It didn't spill over into maths and I would have liked it to ... because it's creative and they're doing something. These kids are very touchy children, they like to touch things, they've got to touch things. Some picked up on it and, some didn't, and I would have liked the 'two over the two under', and making patterns, and getting into the rule, this is how it goes, under over, under over, it always goes like that, you get into*

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rules. They sort of figured it out, teaching each other ... they actually really enjoy teaching each other too ... because we did it as Maori Studies ... but I would like to have been able to pick up more on the maths in it, and the touchiness ... the doing of the maths in it.

[4]Rachel: *I talked to my tutor teacher about how exhausted I was with my daily planning. I went to her, I just mentioned it was really hard work, I wasn't coping really well and she said "No, you don't have to do that". So now I have got three groups, my whole class is divided into three groups and they rotate now. Each day one group is on maths games, one group is with the teacher, and one group is doing some sort of follow up activity from the teaching. Now I have got the routine going I am not so stressed out ... it is just running really smoothly, it is excellent.*

[5]Kylie: *I'm really unhappy with the maths time ... we have to teach it from 1.30 till 2.15 every day. The whole syndicate, the whole school does ... and that's not the way I would like to teach maths. I find it very frustrating. I'd rather, you know, do maths intensively throughout the week than these little compartments, in compulsory time, where I have to do maths. Because it makes more sense ... in fact, I do maths in other areas of the curriculum anyway because quite often I put out reading books about numbers, and about maths, and about patterns, and about all sorts of mathematical concepts, and so we do it when we are doing reading.*

[6]Emily: *They are ability groups. I want to do things like ... sit down individually with every child .... I mean I'm quite good at this sort of thing and I'm quite good with mixed ability groups. But then these*

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ability groupings, because it's easier in the day-to-day running ... I use them, because it's easier. I'm quite keen on mixed ability groups but I feel that if I have mixed ability groups, I also need to provide a bit extra because ... some of the children, they can be quite frustrated.

[7]Claire: *The school likes to show the parents the children's maths books to explain to them what maths the children have been doing. Well, if children are to construct their own ideas and you want the activity to be open and investigative ... take the other day when they were exploring boxes for instance .... We had discussed it. There were these boxes and they pulled the boxes apart. They actually took the boxes apart first and had a look at how they were made. I made them concentrate on how people had put them together. And then I said to them "See what other boxes you can make". Then they made their own, and they talked and talked about them. Well, with things like that going on we haven't got much in our maths books, so I will put more in. What I'll do is, I'll give them worksheets occasionally, and then I'll sit there and fill in the whole lot of books at once. But I shouldn't have to do that.*

Resistant alteration

finding ways of breaking the instructional routines of the school and making decisions regarding content

[1]Tracey: *With their maths play ... there's no meaning for them in adult context at all, so it needs to be a child's context. Its meaningful, they're playing but I'm not bringing in the context. I don't actually give them any context, just equipment if you know what I mean. I suppose its meaningful to them then, within reason, like within guidelines ... because they choose their equipment. Or another thing I try and do is get into their context ... for instance I turned up with*

nothing yesterday, with a piece of paper and I said "Let's have a chat.
We're supposed to be doing this thing called measurement, and we
have to learn about measurement. I'm not sure what this thing
measurement is. So what are we going to be learning about?" I
turned up with nothing because I wanted it to develop in this room. I
didn't present anything in front of them, but I did have, in the room,
rulers, string, pens and things, and they decided the context that we'd
use for measurement.

2Julie: *I don't like BSM* (Beginning School Mathematics resource) *because*
although we've got quite a bit of equipment ... not enough really,
never enough of anything. We were doing measuring and there
definitely wasn't enough equipment so ... we've got other resources,
we've got the curriculum, all sorts of blackline masters all over the
place, that we can use. So I'm learning to put all that together and
plan from what we've got. I like to plan in advance ... instead of a
week before, I like to plan about four weeks before, and then I can
organise the stuff that will be meaningful for the children in what
we're doing.

3Rachel: *I tried to make things that were related to the curriculum. I had*
some copies of stuff that I got from College, and I just copied them
onto coloured card, popped them in a plastic bag and there they were.
Then the addition ones I made up myself.... I just made them up on
card. The children choose, and away they go, and I have found lately
that once they have had a few games, they will swap it with
somebody else. There are enough for all the children in the group,
plus a few left over, so they do rotate them around.

⁴Kylie: *It occurred to me yesterday that when we started talking about things in the classroom .... I mean really talking about things, then you are teaching maths as you are teaching language and social studies and .... I mean we talked about ... oh, you know things to do with the context, and they were processing it ... it's a really complex thing but I think it's important that the children have the chance to talk about the concepts ... and then I'll assess what they are talking about, who is doing the talking, what they are talking about ... some of them couldn't really say what had happened but they had actually taken part, and been part of the mathematics process ... and I think that knowing that, for me, is a really important part of the assessment process. I think it's the tricky things that you can earmark are going on in their brains that lead you to the bigger things ....*

⁵Emily: *I've only got about five children in the class who are prepared to take risks, so every day I try to give the class ten minutes free time with the maths equipment, to encourage them to use it how they want ... to try things out with it. Then I go round and observe what's going on.*

⁶Claire: *I think the context can be made more meaningful for the children if you use things they're used to. There's a lack of materials, here so if I haven't got the equipment I go down the road and buy it at lunchtime because you can't explore that area properly unless you use stuff the kids are used to. Yes, I went down the road at lunchtime last week, and bought straws and stuff like that, and I still didn't have enough. I went down and bought two packets of straws and two packets of toothpicks, and when the kids started chopping them up, and they chopped them up alright, they realised they'd chopped one too short, or something, so they wanted more straws and I didn't*

actually have more straws to give them. But I did feel that was a most successful maths lesson because the children liked what it was they were using.

Transformative action

reflecting on their teaching by considering the uniqueness of the individual pupils

[1]Tracey: *Tomorrow I'm starting measurement. Well I'm supposed to start tomorrow, but I always start every topic the day before ... whole class sort of stuff. I have another teacher who comes in to share and support ... and we tend to be different. She has a group and I have a group, and because our styles conflict we tend to not work together too well. So to introduce a topic, I try and do some whole class stuff and hands-on investigation stuff. So with measurement, today, they went around the room measuring things with pieces of string ... or pencils ... they tended to run around individually once they got the idea. It was quite hard really but they just sort of ... enjoyed it and the point was there, that the desk was so many pencils long. Then we'll (the two teachers) split. She basically plans nothing for those days, I just say "I'm taking a whole class lesson" ... so I get my open bit in at the first two days of each unit.*

[2]Julie: *When it comes to choosing time I'll say it loudly and clearly, giving girls the chance to go on in there, to the Lego, and even when the boys do come in and the girls won't go then, I really push them to go. You see, I'm brave there, because in this room the idea of choosing time is that the children can go freely anywhere.*

[3]Rachel: *Yes, that (no withdrawal) is what frees me up. I now have freedom to have maths when I like. At the beginning of the year I was told*

maths is from 9.30 to 10.15 because of the pulled-out group, but I
have just changed recently. I had reading and language in the same
block after play, and it was too much for the children to concentrate
on. Well, I found they couldn't concentrate and the second lesson out
of those two just went to pieces. So I put language in the morning
when the children had fitness ... they have an active time at morning
tea, they come back in and have reading which is not so active, and I
have found that maths is more active, so then they go onto maths
after that and it has worked well.

[4]Rachel: *Another teacher takes a group a low children, a group of children*
that are having difficulties. They are taken out for that block. None
of mine go, I didn't think any of mine needed to go. I wanted to cater
for them myself. So I was allowed not to take part.

[5]Rachel: *They use a topic-based maths system here ... and the objectives .... I*
found they didn't always match the curriculum. In the curriculum
they are different, so I said I wanted to use the curriculum objectives.
I don't know what the others are doing, and I don't know whether
they found it as much of a problem as I did, but no-one has told me I
can't. I feel much more comfortable about my maths now.

[6]Kylie: *Well, I believe that one of the mysteries of maths, that needs to be*
overcome, is that to understand how something works you have to
actually engage in what's going on. The children in my class, if they
don't get underneath something, if they are not able to dig around it
and look at things from all sorts of perspectives, and experience what
is going on, they're going to be less likely to understand. At the
moment we're doing statistics ... for example, they had to go round

and find out what people's favourite number was ... or the colour of people's eyes. Nothing special about that but ... these are five and six year olds and ... they had to think about how they were going to do this ... and how they were going to tell the rest of us what they found out.

7Emily: *Although we use the BSM objectives I'm starting to use the curriculum to write my own learning outcomes, and assess according to them. It's more work, but it's giving a better idea of what the children's maths is like.*

8Claire: *Normally we sit in a circle for Maths. I haven't really got into groups very much because I hate judging this one and that one. It might be only for this, because I think everyone's different at each thing they do. I hate ability groups, I just don't like them. Sometimes you have to do them but other times I find, normally, it takes me a week on an objective, and then I pull a few out that don't understand and then work with them. I still have groups but not ability groups ... today for instance I just chose them off the top of my head ... there was one group there ... those three boys which I actually didn't put together, one of them must have swapped. And that was interesting because they were one of the real-on task groups .... so I decided not to insist they changed back .... I didn't want to rearrange them in the middle of it ... they did more maths that way.*

9Claire: *I use the curriculum all the time. I think they have to learn maths in a way that's relevant to their lives, and the curriculum gives me ideas. My idea of maths is children doing and doing it ... like making things, not just looking at a piece of paper or a drawing of*

something. Although I'm supposed to use the school scheme I actually teach it how I like. I read through resource books and make sure I'm teaching it correctly, by checking with the curriculum. This seems to meet the objectives required of me better than using the school scheme.