Pre-service Teachers' Experiences and the Influences on their Intentions for Teaching Primary School Mathematics

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In this article results from an examination of beliefs about teaching and learning primary mathematics are reported. Commencing and graduating pre-service teachers completed written surveys and interviews. Common to many pre-service teachers were memories of mathematics lessons with teacher demonstrations, completing set exercises, using mathematical equipment, and playing competitive number-based games. Various factors influenced their beliefs including: having theory linked to practical examples, reflecting on more recent experience of teaching and learning contexts, and listening to experiences shared by friends and family members who teach.

From the research on teachers' beliefs about various aspects of teaching and learning (Kagan, 1992; Richardson, 1996) four assumptions about beliefs are relevant to this article. Teachers' beliefs are context-specific and are held in varying levels of conviction (Beswick, 2003). Long-held beliefs are resistant to change (Block & Hazelip, 1995; Kagan, 1992) and when suitable opportunities present, teachers act in accordance with their beliefs (Stipek, Givvin, Salmon, & MacGyvers, 2001). Fostering the development of pre-service teachers' beliefs is a challenge all teacher educators face; being aware of experiences influencing pre-service teachers' beliefs seems potentially useful. Addressed in this article are two questions:

- Which teaching strategies and/or practices do pre-service teachers intend using in their teaching of mathematics? and
- Which experiences influence the development of pre-service teachers' beliefs about teaching and learning mathematics?

In common with other studies, this article includes a discussion of the influence of pre-service teachers' memories of teaching strategies and approaches used in their schooling (Weinstein, 1989) and the impact of coursework (Kaminski, 2003) on their intentions for their own teaching. Differentiating this discussion from earlier studies is an attempt to address the gap that Munby, Russell, and Martin (2001) claimed exists in traditional teacher education programs which fail to give credence to the insights gained from pre-service teachers' early teaching experiences and their recent observations of teaching contexts.

In this article data are reported and implications for mathematics education are considered based on pre-service teachers' written responses indicating their levels of intention to specific practices in imaginary, ideal

situations. The pre-service teachers' audio-taped comments from interviews that were gathered later identify possible sources for their beliefs.

The discussion begins with a summary of some authors' perspectives about beliefs in general, followed by overviews of studies in teacher education that have focussed on the impact of pre-service teachers' beliefs about their learning. In the remainder of the article the data collection and analysis processes are described, and comparisons made of the influences of differing types of pre-service teachers' beliefs on their intentions for teaching primary mathematics.

Some Perspectives about Beliefs

Some authors suggest beliefs serve as filters for thoughts, decisions and actions (Ambrose, Clement, Philipp, & Chauvot, 2004; Smith & Croom, 2000). Nespor (1987) described teaching as an occupation fundamentally influenced by beliefs. Although there is no agreed definition of teacher beliefs (Beswick, 2003), several authors offer definitions and conceptual frameworks to operationalise beliefs. Pajares (1992) said beliefs are "based on evaluation and judgment" (p. 313) and, being created through a process of enculturation and social construction, are context-specific and personally meaningful.

Beliefs are sometimes described as being different from knowledge. For example, Kardash and Scholes (1996) wrote that "knowledge can be distinguished from beliefs in two ways. … a belief can be false; … a belief may be based on insufficient evidence" (p. 261). Nespor (1987) proposed at least four features distinguishing beliefs from knowledge: "existential presumption, alternativity, affective and evaluative aspects, and episodic structure" (p. 318). *Existential presumptions* describe the "existence or non-existence of entities" (p. 318) that are "stable, well-defined … [and] beyond the teacher's control and influence" (p. 318). *Alternativity* refers to one's conceptualisation of ideal situations; and such beliefs often differ from present experiences. *Affective* and *evaluative aspects* are tainted by feelings about the subject or persons involved. For example, teachers' unconscious feelings about their students or about their conceptions of the subject matter will influence how they interact with their students and how they teach the content. *Episodic structures* refer to personal experience, or are based on knowledge of cultural practices. Nespor drew on schema theory, writing that related beliefs can be thought of as being organised into one's memory as systems.

Pajares (1992) stressed that central beliefs were difficult to change. Block and Hazelip (1995) also argued that altering long-held or central beliefs that underpin others or are intertwined "may be impossible" (p. 25). These researchers were supported by the findings of Kardash and Scholes (1996) who reported that "people's general beliefs about the certainty of knowledge will cause them to distort both highly tentative as well as highly contradictory information to conform to their beliefs" (p. 269). Kardash and

Scholes stressed that simple exposure to different viewpoints does not alter people's existing beliefs.

Stipek, Givvin, Salmon, and MacGyvers (2001) reported consistency between teachers' beliefs about the teaching of mathematics and their practices for 21 upper primary school teachers. Teachers who held traditional beliefs about teaching portrayed more traditional instructional practices and emphasised performance-based behaviours, for example, increasing students' speed in completing items and viewed making mistakes negatively.

At times, despite holding strong beliefs about particular issues, individuals may act in ways that seemingly differ from their beliefs. Sarver (1983) argued that it was not possible to predict human behaviour according to the *theory of reasoned action* for at least two reasons. First, it is impossible to guarantee the presence of the "context of opportunity" (p. 156); and second, unforeseen variables occurring at the "point of opportunity" (p. 158) impact on a person's intention to act in a specific manner.

In this article, *beliefs* mean an individual's opinion or view on a specific issue or practice, and *intentions* describe pre-service teachers' proposed behaviours in ideal situations as part of their planning and teaching of mathematics.

Beliefs and Teacher Education

It seems that beliefs dictate, to a large extent, the degree of pre-service teachers' engagement in, and approach to, a task because they are organised into systems that are inter-related with other like-assumptions that are also resistant to change. For example, beliefs about teaching are likely to be linked with those about learning, schools as organisations, and curriculum. It is fair to assume that pre-service teachers' beliefs about learning mathematics are likely to be important determinants of their approaches to teaching. Teacher education programs need to assist pre-service teachers to appreciate the role of their beliefs and ways their beliefs may influence them.

To assist in the consideration of relevant studies, and the presentation of the data that follows below, a framework by Block and Hazelip (1995) was used. They proposed three types of beliefs: *descriptive*, *inferential*, and *informational* but did not elaborate on them; nonetheless, it seemed an interesting framework for considering pre-service teachers' beliefs and so there has been an attempt to clarify these three types of beliefs in this article. To present an overview of how the model has been adapted and used, each type of belief has a definition, a summary of typical experiences representing its category, and an excerpt from an audio-taped discussion with a participant from the present study.

"*Descriptive* beliefs come from personal observation" (Block & Hazelip, 1995, p. 25, italics added). In this article, beliefs formed from pre-service teachers' memories of their experiences as learners were classified as descriptive.

During a focus group interview, one commencing pre-service teacher shared her experience of a teacher-demonstration. She said:

Belle: I remember being shown additions, tens and units and subtractions on the board.

Interviewer: Just to you or to the whole group?

Belle: The whole group.

In this example, Belle's recollection may lead her to form beliefs about the nature of teacher-demonstrations.

Inferential beliefs arise "as inferences [from] observations" (Block & Hazelip, 1995, p. 25). For example, beliefs formed from more recent experiences as observers during short bursts of teaching practicum, as incidental classroom helpers, or from demonstrations in lectures and tutorial classes were considered *inferential*.

Mandy, a graduating pre-service teacher was interviewed individually and explained why she intended to use group work.

Mandy: My first round was a long time ago but even then I felt that the teacher I was with treated the children like little soldiers and we sat down and did worksheets all day. I just felt that she hadn't really changed. I don't think it was just her but none of the new theories or any of the new ideas were being used. I saw that the children were learning but perhaps not in a motivating environment, they were more scared than excited. I felt, no this is not what I want [but] I had to run with it while I was there, but I thought there was a better way. That was the day or the time when I thought, "No, this group work thing that's really what really works and what the kids are going to be interested in." That was my turning point.

It seemed that the impact of Mandy's observation of one teacher's approach influenced her beliefs about the use of group work and was associated with keeping children interested in their learning.

"*Informational* beliefs come from other sources" (Block & Hazelip, 1995, p. 25, italics added). Beliefs influenced by reading and discussing prescribed texts, or communicating with friends and family members who are practitioners were classified *informational*.

Shauna, a commencing pre-service teacher had regular informal discussions about classroom activities with her parents, both of whom were primary school teachers.

Interviewer: What is it that has helped you shape your ideas about teaching and learning?

Shauna: I have to say my parents. I mean I always ask, "What's going on in the classroom?" and [we talk about] what they are doing and any specific problems they have with kids. Then they tell me how they sorted it out and all that sort of thing. I like to keep an interest in where they are up to.

In this case, Shauna seemed to appreciate the circumstances of being given a verbal description, and she valued the strategies her parents used to resolve classroom management issues without seeing the outcomes herself.

Studies that examined these types of beliefs are described in the following sections. Of course, few studies fit neatly into one classification; therefore, the following studies are positioned according to best fit.

Studies depicting descriptive beliefs

Various researchers in teacher education have argued that pre-service teachers draw on prior, personal experiences as learners, such as preferred learning styles and attributes of teachers, and that these experiences are fundamental to their formulation of beliefs about teaching and learning (Calderhead & Robson, 1991; Richardson, 1996; Weinstein, 1989).

In a study of seven participants, Calderhead and Robson (1991) reported that pre-service teachers in their first year of an undergraduate education course held images of teachers, and teaching and learning situations mostly from their experiences in schools as students. They found that the pre-service teachers' images were inflexible and focussed on specific activities. They concluded that their pre-service teachers lacked knowledge "about children, the curriculum and alternative teaching strategies—to manipulate the images they had in mind" (p. 6). It seemed that these pre-service teachers relied on their memories of their experiences as learners to recall personally significant events and were unable to consider the overall context—their memories were both biased and fragmented.

Weinstein (1989) reported findings from responses of 113 pre-service teachers to a questionnaire with both open-ended and fixed response items. The aim of the study was to replicate findings from an earlier study (Weinstein, 1988) that had reported "unrealistic optimism" (p. 54) from pre-service teachers about many aspects of teaching. The pre-service teachers' responses indicated high levels of confidence in various tasks, ranging from their ability to teach students from different cultures and backgrounds, their ability to deal with discipline issues, classroom management, and to develop interpersonal relationships with parents. In fact, Weinstein (1989) found that 81% of the elementary pre-service teachers predicted that their future teaching performance would be "above average" (p. 57). He then explored possible reasons for this optimistic bias. The most common reason for optimism was their "enjoyment and interest in working with children" (p. 56), and they commonly described a good teacher in terms of their "positive interpersonal relationships" (p. 58). Beliefs about attributes of teachers were based largely on memories of personal experiences. Weinstein argued that teacher educators needed to reflect on the results of the pre-service teachers' responses for two reasons. First, their optimism for teaching may serve to give them a false sense of security, and may make them less likely to value their teacher preparation coursework; second, their conceptions of what a good teacher was did not include pedagogical and subject matter knowledge.

Richardson (1996) reviewed literature about the attitudes and beliefs of pre-service teachers on entering their degrees. Three recurring themes in the studies reviewed were: high levels of confidence and optimism for teaching; a desire to help children; and, a belief that "experience is the best teacher" (p. 108). Richardson concluded that, excluding practicums, pre-service teacher education was seemingly ineffective in changing preconceptions of teaching and learning because of pre-service teachers' strong beliefs formed from personal experiences as students and their experiences of teaching. Richardson argued that if goals of coursework in teacher education included challenging existing beliefs about teaching and learning then pre-service teachers' beliefs about such issues needed to be exposed.

In sum, there is evidence that, left unchallenged, pre-service teachers' beliefs about teaching and learning are grounded in their recollections of personal experience as learners.

Studies depicting inferential beliefs

Using a modified version of the Block and Hazelip (1995) framework, in this study pre-service teachers' *inferential* beliefs about teaching and learning were based on inferences arising from recent observations of teaching contexts.

Hart (2002) argued that most beliefs are formed through experience and observation over time. Hart designed a 30-item survey, the *Mathematics Belief Instrument*, and described a study involving 14 participants in which pre-service teachers completed the survey at the beginning and end of their coursework. Lecturers modelled the teaching strategies they advocated, and fostered a supportive environment in which pre-service teachers problem-solved, communicated their strategies and ideas, and reflected on their learning by recording their thoughts in journals. Hart presented two case studies that illustrated that pre-service teachers' beliefs were consistent with the philosophy of the coursework and current advice from mathematics educators who advocated constructivist approaches. She suggested that the more complex the skill or thinking process, the greater the need for opportunity to observe performance of these in action.

Replicating the study by Hart (2002), Wilkins and Brand (2004) used the *Mathematics Belief Instrument* as a basis to evaluate the extent to which pre-service teachers' beliefs about teaching and learning mathematics were consistent with the philosophy of the current reform in mathematics education, after the pre-service teachers had undertaken the prescribed mathematics methods course. Wilkins and Brand's study involved 89 pre-service teachers all taught by the same instructor. Like Hart, Wilkins and Brand reported positive findings from the study, suggesting that participation in the mathematics methods course led to beliefs more consistent with current mathematics education reform, and some degree of change in pre-service teachers' sense of self-efficacy.

In each of the studies described above, it seemed that pre-service teachers spent considerable time observing best practice and making inferences about approaches conducive to learning mathematics based on these experiences and these, in turn, influenced their beliefs about teaching mathematics.

Studies depicting informational beliefs

Using the modified version of Block and Hazelip's (1995) work, *informational* beliefs develop from discussions with practitioners and reflecting on and discussing prescribed readings. The first two studies described below do not specifically deal with the teaching of mathematics, yet are considered relevant as they imply that teachers' beliefs are contextually-based and make suggestions for helping pre-service teachers integrate theory and practice.

Teachers bring their own experiences, dispositions, and expertise to complex and dynamic classrooms. Unlike other professions, teachers deal with 20 to 30 students at the same time, and make a number of on-the-spot complex decisions impacting on classroom management and student learning. Hatch (1999) argued that pre-service teachers "should experience socialisation into the profession by design, as opposed to by default" (p. 229). In other words, by including information about teachers' work within pre-service teacher education programs, the pre-service teachers may understand ways to adapt to the complex expectations of teaching before they become responsible for student learning. Similarly, Putnam and Borko (2000) stressed that pre-service teachers need to be enculturated into the teaching community to learn the discourse of teachers.

Hatch (1999) suggested teacher education coursework use case studies, invite guest speakers, set up panel discussions, interview cooperating teachers about their work during practicum, and have extended periods of practice teaching in internship-type arrangements in addition to traditional approaches used such as lectures, reflecting on the required reading, participating in group discussions, and completing individual library research projects. To some extent, the strategies offered by Hatch give credence to teachers' work – a shortcoming of some teacher education courses noted by Munby et al. (2001).

In an Australian study, Kaminski (2003) reported on a number sense program in which 43 students enrolled in a mathematics education unit in their second year of a primary teaching course spent much of their time in small group discussions, as well as reflecting on their learning via the use of journals, in preparation for the teaching of mathematics. Kaminski argued that as a result of discussing and justifying solutions in small groups, not only were the pre-service teachers exposed to different strategies but they also increased their bank of mathematical skills and processes.

In the studies described above, pre-service teachers seemed to draw on information from sources other than personal experiences as learners or inferences from observed situations. Indeed, these drew mainly from discussions with others.

Studies depicting three types of beliefs

Most studies examine beliefs from each of the three categories. For example, Stuart and Thurlow (2000) reported challenging pre-service teachers' beliefs regarding the nature of mathematics, themselves as learners, and the teaching-learning process. They gathered data from pre-service teachers' journals, interviews, and their own observations of 26 participants. They suggested that many had entered the mathematics methods class without an awareness that the term *beliefs* was relevant to mathematics. "In their world-view, mathematics simply was: one did not have beliefs about mathematics" (p. 116). Stuart and Thurlow argued that when pre-service teachers reflected on their experiences of mathematics lessons, and shared their personal prior experiences and critically analysed them, they became aware of some of the common beliefs underlying both the nature of mathematics and the teaching of the discipline. They reported that many pre-service teachers successfully re-evaluated and changed their beliefs about teaching mathematics during the course work.

Similarly, Carter and Doyle (1996) suggested that personal practical knowledge includes "formal knowledge, personal aspirations and goals, and cumulative experience integrated in an understanding of immediate, local situations" (p. 123). They argued that pre-service teachers draw on personal experiences as they reflect on the coursework presented to them but they "do not simply copy the methods they witnessed as students" (p. 127). They are often critical of the teaching that they experienced, and they "ignore cases of teaching that differ from their previous experience and sidestep theoretical arguments" (p. 127) offered by academics. "Their ideal images are … based on narrow assumptions about the range of diversity of students' capabilities and interests and on unrealistic beliefs in the power of their own personalities to motivate students" (p. 127). Carter and Doyle suggested that personal narratives can be used to "develop a reflective capacity as a teacher" (p. 136), together with journals and group discussions.

In both of the studies described above, the researchers used pre-service teachers' memories of personal experiences, observations of teachers' practices, and classroom activities to discuss issues in light of the coursework.

The remainder of this article outlines the processes of the data collection and analyses undertaken in this study. In addition, the influences of the differing types of beliefs on pre-service teachers' intentions for teaching primary mathematics are identified.

Method

Survey research and semi-structured audio-taped interviews were used to gain pre-service teachers' perceptions of the similarities and differences in teaching and learning literacy and numeracy. However, the focus of this article is on numeracy, so data related to literacy are not reported. The definition for *numeracy* used here is one's ability to use and make sense of

numerical information. Wiersma (1995) suggested survey research was a viable option to identify participants' perceptions of the presence or absence of links between variables in non-experimental research with no existing data. In this study, key issues arising from pre-service teachers' written responses to questionnaire items provided the basis for further refined data collection in which purposefully selected pre-service teachers participated in semi-structured audio-taped interviews.

Beliefs about teaching and learning numeracy were sought from two groups of pre-service teachers: those commencing and those graduating from pre-service primary teaching degrees, mostly three years apart. The participants were studying teacher education courses at two tertiary institutions in Australia, one had an inner city location, and the other was in a regional centre. Early in the second semester of the first year of their courses 163 commencing pre-service teachers completed written surveys, and during the final weeks of their courses 186 graduating pre-service teachers also completed the written questionnaire. The deliberate use of a cross-sectional sample of the pre-service teacher population sought to identify participants' intentions at two points during pre-service courses. Of course, inferences drawn from such data are limited nonetheless; these provide useful insights for teacher education programs. The *Pre-service Teacher Intent Questionnaire* (PTIQ), comprising 65 items, was an adaptation of the Undergraduate Teacher Intent Questionnaire (UTIQ) piloted a year earlier with 163 participants (Scott, 2003). Both instruments required participants to consider specific beliefs about learning and teaching for two disciplinary areas – literacy and numeracy. However, only data related to numeracy are reported here.

PTIQ items were categorised into two sections: *Personal educational history* and *Intentions for teaching*. The former of these focussed on identifying pre-service teachers' personal experiences as learners of literacy and numeracy. Using a series of tick-box, selected-response items, participants were instructed to tick those which best described their experiences (Gorard, 2001). The item in Figure 1 is an example from the first section, comprising 10 items.

My experiences of learning mathematics in primary school were mostly …

- teacher-demonstration
- completing set exercises by myself
- teacher-demonstration followed by set exercises by myself
- teacher-demonstration followed by activities with my peers
- none of the above
- can't remember

Figure 1. Personal educational history: Item 8.

Even though only a limited range of possible choices was available, it was found in the pilot study that these were all the options needed.

The latter section of the PTIQ focussed on identifying pre-service teachers' intentions for frequency of specific teaching strategies and practices. The five-point scale enabled participants to indicate how often they intended to include a particular strategy in their literacy and numeracy lessons. The range incremented by 25% of lessons, which spanned from 100% (in every lesson) to 0% (meaning never). Also included was a "don't know" (D) option. The item in Figure 2 is an example of the 43 items in the second section of the questionnaire.

In __% of lessons	Beliefs about learning	In __% of lessons
Literacy	*I intend to…*	Numeracy
100 75 50 25 0 D	use class discussions because I believe that children learn from each other.	100 75 50 25 0 D

Figure 2. Beliefs about learning: Item 7.

Using the *funnel* approach described by Wiersma (1995), participants' written responses to the questionnaire provided the initial data about the general research questions. As significant issues became apparent, more focussed data were gathered via interactive methods such as interviewing selective participants. Towards the end of the year, of the 349 pre-service teachers surveyed, 17 graduating and 14 commencing pre-service teachers were interviewed either individually or in focus group situations, depending upon volunteers' availability, for approximately 30–40 minutes. Descriptions of their memories of their own schooling experiences were sought. Interviewees were given open-ended prompts such as: "Describe a typical numeracy lesson from your primary school days". Using the same questions and format for focus group and individual interviews, all discussions were audio-taped and later transcribed verbatim. Interview transcripts were first read for potential commonalities, and preliminary categories were formed. Key issues were coded, in some cases with sub-nodes, with the assistance of a qualitative software program, NVivo (Richards, Richards, Fraser, & Barrington, 2000). Data grouped into similarly coded sections were inspected for coherence. Discrepant comments were re-categorised, or where necessary new nodes created to integrate them.

Results

The presentation of excerpts of the data alongside quantitative data from the pre-service teachers' responses to PTIQ allows readers to gain a sense of the

pre-service teachers' experiences, and to see how these influenced their intentions for teaching and learning numeracy. The presentation is grouped according to the three types of beliefs.

Descriptive beliefs

The first category of beliefs encompasses those formed by personal experiences. Reported first are some pre-service teachers' memories of learning numeracy themselves in primary school from two sources: PTIQ, item 8 which compared common experiences of learning numeracy in primary school for both groups (commencing and graduating pre-service teachers); and pre-service teachers' responses to the open-ended question shared during audio-taped interviews, "Describe a typical mathematics lesson from your primary school days." Excerpts included are mostly from participants interviewed individually, unless otherwise stated.

In Table 1 the most common experiences of learning mathematics in primary school for both groups of pre-service teachers are presented.

Table 1
Most common experiences of learning mathematics in primary school.

My experiences of learning mathematics skills in primary school were mostly …

	Commencing (n=163)	Graduating (n=186)
teacher-demonstration	51 (31%)	25 (13%)
set exercises completed by myself	22 (13%)	34 (18%)
activities completed with my peers	23 (14%)	13 (7%)
activities planned for my needs	4 (2%)	3 (2%)
teacher-demonstration … set exercises	11 (7%)	33 (18%)
teacher-demonstration … activities with my peers	12 (7%)	6 (3%)
teacher-demonstration … activities for my needs	0 (0%)	1 (0.5%)
teacher-demonstration, set exercises and activities with peers	18 (11%)	17 (9%)
completed set exercises by self and with peers	0 (0%)	2 (0.1%)
can't remember	22 (13%)	52 (28%)
none of the above	0 (0%)	0 (0%)

Overall, the experiences of learning numeracy in primary school were quite similar for the two groups. Three minor differences included: a slightly higher proportion of commencing (31%, n=51) than graduating (13%, n=25) pre-service teachers reported having experienced teacher-demonstrations; this was a surprising finding. Twenty-eight per cent (n=52) of graduating pre-service teachers could not remember their experiences which seemed

reasonable; hence, there are fewer excerpts from graduating pre-service teachers about their experiences as learners. Around 18% (n=33/34) of graduating pre-service teachers either completed set exercises by themselves or following teacher demonstrations, while around 13% (n=22/23) of commencing pre-service teachers completed set exercises individually or with peers.

Excerpts from interviews with pre-service teachers provided fragmented scenes of primary numeracy lessons. Nonetheless, these contextualised the data presented in Table 1. Unfortunately, since graduating pre-service teachers interviewed were often unable to recall specific details, most of the recollections are those of the commencing pre-service teachers.

Teacher-demonstrations

A common description of a typical lesson in numeracy commenced with a teacher-demonstration. For example, a commencing pre-service teacher who entered the pre-service primary course several years after completing Year 12 recalled:

> Sandy: In maths, it was probably a demonstration of the teacher writing up a sum on the board and sort of doing the first one, demonstrating how to do the sum.
>
> Interviewer: Do you remember doing problem solving tasks?
>
> Sandy: No, no. Do you mean like: "Fred has five dogs and seven cats and he bought them for $15. How much did each cost?" Um no, and I struggle with problem solving now. I used [to think] "Why are we doing this, what am I ever going to use this for?"

Another commencing pre-service teacher said:

> Bess: I remember in Grade 6 our teacher used to like us to do the things the way that she had taught us to do them and not to use any other methods than what she had said.

It seems that these memories of teacher-demonstrations suggest teachers' methods or approaches are desirable and are a feature of the lesson's introduction. Such experiences may influence pre-service teachers' beliefs about teaching numeracy.

Using mathematical equipment

Common to commencing pre-service teachers were experiences of using equipment, playing games, and completing worksheets.

In Tables 2 and 3 written responses from pre-service teachers for two PTIQ items regarding their intentions to use equipment in their teaching of numeracy in the future are presented.

Table 2

Comparison of intentions using physical objects when introducing new concepts.

I intend to use physical objects when introducing new concepts for learning numeracy in …

	25% of lessons	50% of lessons	75% of lessons	every lessons	Don't know
Graduating (n=186)	2 (1%)	7 (4%)	56 (30%)	120 (65%)	
Commencing (n=163)		12 (7%)	41 (25%)	107 (66%)	1 (0.6%)

Table 3

Comparison of intentions to provide lots of materials so children can touch objects when they're learning

I intend to provide materials for children to touch when learning numeracy in …

	never	25% of lessons	50% of lessons	75% of lessons	every lessons	Don't know
Graduating (n=186)		2 (1%)	13 (7%)	58 (31%)	110 (59%)	
Commencing (n=163)	1 (0.6%)	2 (1%)	12 (7%)	42 (26%)	104 (64%)	1 (0.6%)

Over 90% of pre-service teachers intended using physical objects when introducing new concepts in either 75% of lessons or in every lesson (Table 2). The strong commitment to this intention from even those commencing their courses suggests that coursework was not likely to be an influencing factor.

Indeed, many pre-service teachers interviewed remembered using equipment, especially counting and place value materials such as *Multi-base Arithmetic Blocks (Base Ten)* (MAB). These concrete materials are used in Victorian primary schools in teaching the representation of, and operations with, whole numbers. A commencing pre-service teacher said:

Bess: We used to get the little blocks, like the 100s and 1,000s blocks.

Other commencing pre-service teachers named different equipment, for example:

Sandy: Yes, I do remember using those [MAB] in probably [grade] 3 or 4. I remember using abacuses, those counting things.

Although many commencing pre-service teachers recalled using mathematical equipment during their lessons, few were able to remember the contexts clearly. It seems that pre-service teachers' experiences as learners, or their memories of them, may impact on the formation of their beliefs about using materials in numeracy lessons.

Similarly, the majority of pre-service teachers (90%) intended to provide materials for children to touch when they were learning numeracy in all or at least 75% of their lessons (Table 3). This suggests that most pre-service teachers generally value the practice.

During interviews, participants shared their experiences of, and access to, mathematical equipment while they were at school. The availability and frequency of using different equipment varied. A commencing pre-service teacher recalled:

Bindy: They had those building blocks, those little cubes. I remember those. I think they had counters and all that sort of jazz, I remember using those on occasions.

In contrast:

Shauna: I remember going outside with the trundle wheels and all that kind of stuff. Our school was very well equipped so the classroom had its own equipment. At lunchtime it was always available. Just for fun, we would get the trundle wheel out and go do something with it.

Some saw the need to use concrete materials often. For example, during a focus group discussion, one said:

Jackie: I would use different objects even if we weren't doing something new.

Only one pre-service teacher referred to using calculators.

Sue: I don't think we were allowed to use calculators.

In short, unprompted, these pre-service teachers recalled using materials in their numeracy lessons and these memories may contribute to the development of descriptive beliefs.

Mathematical games

Another common feature of numeracy lessons was participation in number-based games. For those already confident in numeracy, there were memories of excitement and satisfaction:

Sue: [Teachers] normally made it sort of fun like jumping for smarties. I suppose I enjoyed it because it was easy to grasp, … they explained it and used objects and visuals.

This experience may lead Sue to believe that effective games are easy and enjoyable.

During a focus group discussion, two commencing pre-service teachers shared their experiences:

Summer: In Year 6, we used to do time trials. We got a sheet of maths questions and it was sort of a race test to finish them off and

> the one who had the most right and had finished in a certain time [frame] got their name on the board and got rewarded. They always got you really excited.

Summer's experience may lead her to believe that effective games are those which emphasise speed. Another participant added:

> Rachel: A game we used to play was like adding or multiplying. [If you had the ball, you call out] "2 plus 2" and you throw the ball to somebody and they catch it. If they dropped it, they were out. If they said the wrong answer to the question they were out too and they sat down [until] there were only two people left. It was fun.

Successful participation in this game not only relied on students' recall of number facts but also on their hand-eye coordination. This may lead some to believe that the focus of the game need not be about mathematics.

On one hand, it is fortunate that these pre-service teachers remembered playing games as positive experiences – they were possibly successful players. On the other hand, perhaps they formed some counterproductive beliefs about features of effective mathematical games.

For those pre-service teachers who were less successful players, memories of competitive games contributed to their poor self-esteem in numeracy. Two commencing pre-service teachers in a focus group recalled:

> Melinda: We had races too, like teams, and you have like one line there and one line there, and there would always be one good person, and you were always trying to beat that person.

> Jackie: Yeah, that person would stand up at the front of the line and they wouldn't have to go to the back. That was awful. You got so nervous if you were against them, as you wouldn't have a chance to answer it before they answered it, so by the end of it you just didn't bother thinking about it because you knew they were going to get it.

Participants often described competitive number-based games reinforcing an understanding that success in numeracy requires speed and accuracy. Of course, these two skills are important; however, some games also enhance students' mathematical understandings (Sullivan, 1993).

Seatwork

As part of a lesson, sometimes students complete tasks back at their desks. The pre-service teachers' intentions to use tasks children can do without the teacher's help are presented in Table 4.

Table 4

Comparison of intentions to use tasks children can do without the teachers' help

I intend to use tasks children can do without the teachers' help …

	never	25% of lessons	50% of lessons	75% of lessons	every lessons	Don't know
Graduating (n=186)	11 (6%)	36 (19%)	62 (33%)	57 (31%)	20 (11%)	
Commencing (n=163)	13 (8%)	31 (19%)	50 (31%)	45 (28%)	17 10%)	5 (3%)

Again, the pre-service teachers' responses to this PTIQ item were quite similar. About 40% of the pre-service teachers intended using tasks children can complete without teachers' assistance in either 75% or in every lesson (Table 4), suggesting that these pre-service teachers do not value this practice highly or consider it as appropriate as other practices. Interestingly, this intention gained the strongest level of rejection, or most number of never responses, from participants.

Some experiences shared during interviews may explain the pre-service teachers' low level of commitment to this practice. Many pre-service teachers mentioned completion of worksheets as part of the lesson. For example, during a focus group discussion, Melinda said:

> Melinda: We had a lot of individual sheets mainly in [grades] 4,5,6. One [year] in particular, we had sum after sum, it might have been multiplication, addition or whatever. Down on the side [of the page] there was a thermometer [with] numbers, [showing your] score like 20 out of 50.
>
> Interviewer: Did everyone get the same worksheet?
>
> Melinda: Yes. If you finished early, you might have a more complex [worksheet to do].

In another interview:

> Bindy: We just had sheets and that was it and if you had a question you asked and then there was an explanation for the whole class.

Melinda and Bindy's experiences may lead them to believe that students learn numeracy by completing worksheets and that teachers teach only in response to students' questions about difficult items on worksheets.

For some of the pre-service teachers interviewed, completing worksheets reinforced a poor self-image in numeracy. For example, one member of a focus group discussion said:

> Rachel: I remember getting a lot of crosses on my sheet and I just kept it quiet and kept it from other students so that no-one would realise how silly I was. I wasn't able to get them

right. I think I got away with hiding it. I don't remember getting any help.

It seemed that Rachel formed a belief about her incapacity to learn.

During another focus group discussion, an interviewee described her experiences of working from graded booklets:

Samantha: Yeah, basically worked your way through book work and did whatever chart they graded you to start off with and you worked your way through the charts.

Interviewer: Did you like working with the equipment?

Samantha: I can't remember working with concrete material, just working through the book.

Interviewer: So did you do that every day?

Samantha: Yeah, I sat on that every day and the teacher would come by and put a little signature next to where you were up to and then you had to get a lot more done before they came and signed again. But you felt like you accomplished something because you worked your way through the book onto the next chart. It was a good feeling.

Perhaps such experiences may lead pre-service teachers to believe that learning is an individual activity, or that working through graded books caters for individual needs.

Interviewees shared memories of being bored and of not seeing the relevance of worksheets. One said:

Bess: We would sit there, learn and listen to what the teacher had said. Then we would go and do worksheets afterwards and just do repetition of the same thing over and over again until we were eventually supposed to have learnt what we had been taught. Knowing why never came into it I don't think.

Interviewer: Not in English or Maths?

Bess: English it might have a little bit, but Maths no.

Perhaps Bess' experience of completing worksheets influenced her beliefs about which tasks are useful to students' learning.

Others remembered completing problem-based worksheets. For example, during a focus group discussion, one member said:

Melinda: We did [these sheets] during class and they were like problem solving in real life [situations]. That was in about grade 5. There were a few worksheets for things that applied to real-life but it was just something we did at school.

It seemed that although there were attempts to set numeracy in real-life contexts, links between school learning and life in general did not occur automatically.

Pre-service teachers recalled differing experiences of working on problem-solving tasks including problem-based kits. For example:

Bess: In Year 5 and 6 we had one day a fortnight where we would do problem solving, like little pink container boxes with problem solving activities in them, and we would spend how ever long doing some of them every fortnight.

In another interview:

Shauna: A lot of our maths was done out of the classroom in a maths task centre where we all worked individually out of boxes.

These experiences may lead some to believe that strategies used in problem-solving tasks were additional activities instead of being an integral component of numeracy lessons.

It seems that these pre-service teachers formed beliefs about teaching and learning based on their experiences as students learning numeracy. For the pre-service teachers interviewed it seemed that: one was either good or bad at numeracy; success in numeracy seemed measured by one's speed and accuracy with completing worksheets or winning number-based games; students used equipment in numeracy lessons; and, the role of the teacher was to demonstrate how numeracy was done. Left unchallenged, these pre-service teachers' beliefs contradict some sound teaching practices.

Group work and discussion

Memories of being allowed to talk were more evident than being encouraged to talk mathematically. For example:

Lanie: When we were working things out within the class we were allowed to discuss it with each other.

Others remembered being encouraged to work silently. For example:

Bess: In maths we were encouraged to work by ourselves to figure it out.

There were those who appreciated the quiet environment. During a focus group discussion, one said:

Jackie: One teacher was like "silent when you are doing your maths." I actually found it helpful because it meant that I could concentrate and I could just do it and not get distracted by people talking.

Perhaps these pre-service teachers did not experience or learn the difference between social talk and talking mathematically in their primary numeracy lessons. However, having students and teachers communicate and justify

strategies is a feature of an effective numeracy lesson. Therefore, pre-service teachers' lack of experience in this area needs to be addressed explicitly in their pre-service coursework, that is, pre-service teachers need to learn ways to help children talk mathematically.

During a focus group discussion, a commencing pre-service teacher explained that completing worksheets determined the composition of groups:

> Summer: Overall, we'd all be taught the same thing and then we would all go and do the worksheet. From that the [teacher] figured out who was having problems with it and who wasn't and he'd always correct the worksheets real quick.
>
> Interviewer: What happened if you had trouble with the worksheet, or at the end you got it back and found you got a low score?
>
> Summer: I think when we did our group problem solving the groups were organised into different groups of who was having trouble and who was doing okay.

Apart from this case, the pre-service teachers interviewed did not mention being assessed in numeracy, nor did they mention ways teachers catered for differing abilities once the pupils had been assigned to groups.

Interestingly, although commencing pre-service teachers indicated experiencing group work in their primary numeracy lessons, not all shared the same understanding of the term. For some, group work referred to sharing of equipment and resources; for others it meant working with a partner or peers in small group situations and involved some independent activity. Some noted that students were grouped according to performance on worksheets. No one mentioned teacher intervention in their descriptions of group work.

The pre-service teachers frequently recalled students using equipment and completing worksheets. The introduction of problem-based tasks was evident. However, their usage appeared as weekly episodes rather than as ways of presenting mathematical issues or concepts to engage students. Communicating strategies were not evident in these participants' recollections.

As reported earlier in Table 1, graduating pre-service teachers reported mainly experiencing learning through a combination of teacher demonstration and completing set exercises. To some extent, experiences were similar for commencing pre-service teachers but they also remembered completing class activities with peers. The comparison seemed significant at first. However, follow-up discussions with these participants showed that apparent changes in teaching practices were less striking than expected. Most descriptions from participants' personal experiences contextualised their PTIQ teaching intentions.

Further analyses of the data suggested that pre-service teachers do not only replicate those experiences they themselves had as learners. In Table 5, the two groups of pre-service teachers' intentions to find out and build on children's experiences are presented.

Table 5
Comparison of intentions to find out and build on children's experiences

I intend to find out and build on children's experiences in …

	25% of lessons	50% of lessons	75% of lessons	every lesson
Graduating (n=186)	1 (0.5%)	8 (4%)	56 (30%)	121 (65%)
Commencing (n=163)	6 (4%)	31 (19%)	69 (42%)	52 (32%)

Clearly, graduating pre-service teachers intend finding out and building on children's experiences more often than those commencing their courses (Table 5). An analysis of the written responses from the pre-service teachers interviewed and their experiences as learners makes this point more obvious.

In Table 6, the 31 interviewed pre-service teachers' personal experiences of learning numeracy in primary school and their intentions for finding out and building on children's experiences are compared.

Table 6
Comparison of pre-service teachers' personal experiences of learning with their intentions to build on children's experiences

	My experiences of learning mathematics in primary school were mostly …	Intention to find out and build on children's experiences in numeracy …			
		In 25% of lessons	In 50% of lessons	In 75% of lessons	In every lesson
Graduating (n=17)	teacher-demonstration				4
	completing set exercises by myself			1	3
	teacher-demonstration … set exercises by myself			2	4
	teacher-demonstration … activities with my peers			1	1
	can't remember				1
Commencing (n=14)	teacher-demonstration	1	1		1
	completing set exercises by myself		1		
	teacher-demonstration … set exercises by myself		1		
	teacher-demonstration … activities with my peers		4	1	1
	can't remember			2	1

The four in the top right-hand column of Table 6 indicates that four out of the 17 pre-service teachers interviewed and graduating from their courses who, as learners of numeracy themselves, experienced mostly whole class teacher demonstrations intended to find out and build on children's experiences in every numeracy lesson. In contrast, only one of the 14 commencing pre-service teachers interviewed held the same intention.

It seems that regardless of graduating pre-service teachers' personal experiences as learners of primary numeracy, all those interviewed indicated their intentions to find out and build on children's experiences in most numeracy lessons. It is highly likely that the factor differentiating the graduating from the commencing pre-service teachers is that they have just completed their coursework.

Considering the differences in the pre-service teachers' intentions for this item, it was also of interest to identify the impact of inferential and informational beliefs (Block & Hazelip, 1995).

Inferential beliefs

Some responses were consistent with inferential beliefs (Block & Hazelip, 1995). For example, interviewed pre-service teachers referred to recent experiences working with children in various settings as assistants in out-of-school-hours programs. A commencing pre-service teacher said:

> Bess: I worked at Aftercare while I was at school and helping the children with some of their homework helped me to learn how they were learning and what worked best worked for them.

This example not only created an opportunity for professional learning but it may also influence Bess' beliefs about learning.

Tutoring is another common experience that pre-service teachers valued. A graduating pre-service teacher said:

> Mandy: I am helping a grade 6 child pretty much because she has moved schools. She's been to about three primary schools in the last 18 months so I'm just trying to help her out with her maths mostly. It helps me I suppose, it gets me experience and I see some strategies that might work.

Mandy's inferences about the effectiveness of some strategies are based on her observations of one child presumably working with the teacher's full attention with minimal distractions. Perhaps she will adjust her beliefs about the effectiveness of such strategies given a classroom context.

During interviews, there were 30 references from pre-service teachers about being influenced by practices of lecturers or reflecting on the actions of experienced teachers they observed during the practicum in schools. Some of these observations contributed to the development of inferential beliefs. Common to many was this response from one graduating pre-service teacher:

Interviewer: I'm just wondering on what basis did you formulate this belief?

Ally: More on what I saw on rounds, practicums, just seeing the different teaching styles of the teachers. I sort have gone well, I like what you did there but I really don't like some of the other stuff, so I have picked out what I liked the best out of all of them and sort of said well I like how you deal with literacy and I like what you do with maths and picked out things that way.

The excerpt between Ally and the interviewer reaffirms the need, identified by Hart, (2002), for pre-service teachers to have opportunities to observe more complex skills or thinking processes in action. Therefore, not only are their beliefs and understandings influenced by what they observe but they also appear to be critically selective as well.

Nine of the 17 graduating pre-service teachers said they observed teachers teaching the formal language of mathematics and encouraging children to talk mathematically during practicums. However, teachers' practices and pre-service teachers' interpretations of them varied, and some pre-service teachers questioned what they observed. One graduating pre-service teacher said:

Kathleen: I got into trouble for using an old fashioned word such as adding or add. You weren't allowed to say that and I wasn't even allowed to use the word plus! In the junior classes, teachers are doing [professional] development and you have to say count on or count back. You are not allowed to say plus or add but it just comes out and I think the children should know both because that's what their parents are going to say when they are doing their homework at night. "That's a plus," and [the children] would say, "what's a plus? That's count on mum." Why can't they learn both?

It seems that pre-service teachers do reflect on what they hear teachers say during their practicums but at times may not have the courage to ask their supervising teachers for the rationales driving specific teaching practices. Kathleen began to question her beliefs about the correct use of formal language of mathematics with children and the implications for parents.

Of course, all contexts are open to multiple interpretations and there is no guarantee that inferences drawn will be similar to what was anticipated. For example, some comments from the pre-service teachers indicated some disbelief in approaches advocated by lecturers because of a disparity between what they heard and how they saw ideas presented in their pre-service teaching courses. Another graduating pre-service teacher captured the sentiments of others:

Betty: Well unfortunately what I have learnt at [university]
                  especially doing a teaching degree is that [university
                  lecturers] don't always practise what [they] preach as far as
                  teaching is concerned. For example, the styles of teaching
                  [used] at [university] we are told not to do because [they
                  are] not effective for learning to occur and yet that's the
                  way [they] teach.

It seemed that when conflicting views about teaching practices arose, it was
more likely that pre-service teachers would choose sources with a practical
nature other than those only presented as theory in tertiary institutions. The
following excerpt is a continuation of a discussion with Betty:

Interviewer: (Referring to some data from PTIQ responses) Very few
                  graduating students said that they would teach literacy
                  and numeracy as part of their integrated units of work. I'm
                  just wondering why do you think pre-service teachers
                  would do this?

Betty: I think because it can be quite difficult to do, and because
                  the way it's all structured like they have the literacy block
                  and the numeracy block. They are kept separate. [Also,] it
                  can be a bit tricky especially for the younger grades.

Interviewer: During practicums, have you seen teachers [teach] literacy
                  and numeracy separately or have they been integrated into
                  the unit of work?

Betty: Separate, most of the time it's been separate.

Interviewer: At Uni have [lecturers] encouraged you to teach them
                  separately or have you been encouraged to integrate them
                  into units of work?

Betty: Keep them combined, integrated.

However, when pre-service teachers saw lecturers' actions match their
advice they were more likely to value input gained from their coursework.
This excerpt is a continuation of the discussion between Ally and the
interviewer commenting on the delivery of content in some education units.

Interviewer: Was that true for the mathematics education units you did?

Ally: No maths is more hands on. We had a fantastic maths
                  lecturer where he actually, instead of giving us notes and
                  notes, he would come in and give us examples of things
                  and how you teach this in the classroom.

This seems to be an important implication for teacher educators. If a goal of
education units is to influence pre-service teachers' intentions for teaching
and learning, lecturers need to show explicitly how alternative approaches
may be executed and implemented as part of their delivery of the content.

It seems that the pre-service teachers formed beliefs and understandings resulting from observations and experience, both formal and informal. This had an impact on the development of ideas. It seemed that practicum observations were more salient than their lecture experiences, although some such experiences did influence the pre-service teachers.

Informational beliefs

The most common examples of experiences contributing to *informational* beliefs included those in which pre-service teachers were influenced by other sources, namely, discussions with friends and family members who teach. For example, interviewee Jane sought assistance and advice about teaching-related issues from her boyfriend's mother. The following two excerpts are from graduating pre-service teachers during a focus group discussion.

Interviewer: Jane, to what extent has talks with [your friend, who is a teacher] influenced you?

Jane: A lot I think. Whenever I need anything, I go to that person so she'll give it to me. Before my last round, I got a copy [of my assignment] she did a search at her school library and gathered the books that would help me. She was a huge help and yeah, just giving ideas and helping me.

Interviewer: How long have you been having these ongoing discussions?

Jane: It's actually my boyfriend's mother so ever since I started the course. It's so good, and even leading up to making most of my decisions in the course.

Several pre-service teachers also valued discussions with friends who had recently graduated. One interviewee said:

Emily: I have a few girlfriends who have already been through [the course] and are teachers now so every time we see each other it's teacher talk.

It seems that pre-service teachers value advice from professional family members and friends for two reasons: their advice is situated in the present moment, and it represents authentic contexts. Therefore pre-service teachers perceive the advice as valid and reliable. Of course, all accounts are biased and multiple viewpoints are omitted. However, it is difficult to gauge how critical pre-service teachers are of these accounts and advice. Equally relevant is that pre-service teachers' friends and family members with teaching experience form the basis of their professional network or personal support group. These people act as resource agents for pre-service teachers because they are willing to share their opinions about educational issues, have access to materials and equipment, or at least know where to obtain them.

Information gained from other sources such as reflecting on set readings may also develop information beliefs (Block & Hazelip, 1995). The impact of coursework on graduating pre-service teachers' intentions was evident especially in discussions about using correct terms with children in numeracy lessons. Many of them held similar views to the following comments shared during a focus group discussion:

Jenny: It is important to use correct language when talking mathematically because it's a good communication skill, there's no misunderstanding when you talk mathematically. It helps children to realise that there are different languages for different areas in their lives. Like there is a mathematical language, there is a science language, there's a cooking language, there are all sorts of languages.

Max: There's no use learning about a subject and not knowing the vocab, it's all part of it. So if you are going to have proper knowledge then your vocabulary is part of it.

Dianne: I've been told that reflection and mathematical thinking is a very big part of it and they need to get up and tell the class what they have done, so they need to have a grasp on that language.

Interviewer: Who told you?

Dianne: The lecturer in maths.

Twelve of the 17 graduating pre-service teachers interviewed recalled hearing lecturers highlighting the importance of developing children's subject-specific vocabulary. During another focus group discussion, Bree, recalled a specific lecture on decimals:

Bree: Because I have always clicked onto maths pretty quickly I haven't had to explain it properly so I haven't had to use the terms. But children are not all going to be at my level obviously. The decimal lesson really opened my eyes instead of saying "two point six six" (2.66) which just comes off the top of your head, they say "two and sixty-six hundred[ths] or whatever" so that they can understand that's point six six (.66) it's not just sixty-six (66) or it's not just two numbers.

It seems that pre-service teachers do value lecturers' input about some issues, especially when they see direct links to their teaching and learning.

Of course, lecturers also present theories without demonstrating their applications. One graduating pre-service teacher was overwhelmed by too much content and said:

Ally: Uni is more theory and they cover so much that is irrelevant. It just hasn't been practical at all and it just felt it was wasting my time, so on practicums is definitely

> where I have taken more stuff in and I have opened my
> eyes to what I would do.

It seems that some pre-service teachers fail to make links between theory and practice by themselves.

Pre-service teachers are more likely to accept advice from friends and family members who teach because they speak from real-life contexts. Accepting advice derived from discussions integral to coursework are more influential when they are validated by other sources or when pre-service teachers see implications for their teaching.

Conclusion

In this article, a modified version of Block and Hazelip's (1995) framework of beliefs was used to analyse data on pre-service teachers' intentions for teaching primary school numeracy. Data on the beliefs were categorised by whether they were *descriptive*, *inferential* or *informational*.

Data were collected from 163 commencing and 186 graduating pre-service teachers' written responses to the PTIQ survey, and from interviews with 31 of the same pre-service teachers. The results indicated some stereotypical features of numeracy lessons. The pre-service teachers recalled many childhood lessons beginning with teacher demonstrations of mathematical processes to the whole class, using mathematical equipment such as MAB and counting materials, playing competitive number-based games, and completing worksheets. To a lesser extent, there was evidence of some commencing pre-service teachers completing problem-based tasks on a weekly basis in the senior primary classes.

There was little evidence of these people having had experiences that emphasised talking mathematically with their teachers or peers, assessing students' mathematical knowledge, or using calculators. Nevertheless, pre-service teachers held high levels of commitment for some of these practices.

The data also indicated that graduating pre-service teachers' intentions for teaching numeracy differed from those commencing the same courses. In particular, more graduating than commencing pre-service teachers intended to find out and build on children's experiences, and they valued teaching their students to use the formal language of mathematics. It was concluded that factors other than personal experiences as learners influenced the formulation of the graduating pre-service teachers' intentions for teaching primary school numeracy.

More recent experiences and observations, both informal and formal, seemed to influence the development of the pre-service teachers' beliefs. In fact, they seemed to think that all of their recent experiences of teaching in non-classroom settings contributed to their understandings of how people learn as well as how to teach. They were slightly critical in their reflections of teachers' practices during practicums but did not necessarily seek clarification when they did not understand a supervising teacher's advice. Indeed, the pre-

service teachers valued lecturers' input when their teaching practices and the coursework's content were clearly linked and explicitly demonstrated.

To a lesser extent, discussions with peers, lecturers, and friends who teach were also influential, as were the pre-service teachers' understandings gained from discussions of prescribed readings. Interestingly, when the pre-service teachers noted a mismatch between theory and practice their intentions were influenced by sources offering practical advice. These sources were often from practising teachers in the pre-service teachers' social network. The pre-service teachers were less critical of their advice – perhaps because they considered them situated in present and authentic contexts.

In sum, it is suggested that teacher educators could consider the following facilitating experiences for pre-service teachers:

- to share memories of learning and teaching strategies experienced as learners themselves and consider their appropriateness for meeting the needs of children now and in the future;
- to explore helpful hints and anecdotal stories from friends and family members who teach in the light of recent findings from research in numeracy education;
- to present and explicitly model alternative approaches and strategies in ways pre-service teachers see the benefits to learners as practical, achievable options;
- to discuss relationships between some beliefs and intended behaviours given specific contexts and/or opportunities; and,
- to link new approaches and strategies for teaching with examples from various sources.

Having said all of this, it seems that the deeper issue challenging tertiary educators goes unresolved, that is, how best to include such recommendations within the constraints of teacher education programs.

Acknowledgement

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