

Primary School Teachers' Beliefs Relating to Mathematics, Teaching and Assessing Mathematics and Factors that Influence these Beliefs

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This study examined primary teachers' beliefs on teaching, learning and assessing mathematics. In particular, it considered the nature of the beliefs of primary school teachers with regard to mathematics as a subject, and teaching and assessing mathematics. By factor analysis of survey items, it confirmed many theoretical constructs derived from the literature: three major purposes of assessment – to inform the teacher, to inform the learners, and for accountability purposes; two approaches to teaching mathematics – a transmission approach and a constructivist approach; and two views of the nature of mathematics – a static view and a mechanistic view. A third view of mathematics – the dynamic problem-solving view did not form a factor, indicating that this was not a distinct view for the teachers, which is of concern. The study also considered the relationships between these beliefs and specific teacher characteristics, such as gender, years of experience, grade level and qualifications in mathematics. Female teachers scored more highly than male teachers on using assessment to inform the teacher and the learners. The static view of mathematics increased along with grade level, as did the contemporary view of teaching mathematics. The use of assessment to inform the teacher decreased with increasing grade level. There were no clear trends in beliefs with respect to teaching experience or qualifications in mathematics.

Over the last decade there have been calls for teachers to adopt fresh understandings of mathematics and the learning and teaching of mathematics (Australian Education Council [AEC], 1991; National Council of Teachers of Mathematics [NCTM], 2000) – understandings which emphasise (a) the patterning and real-world problem-solving facets of mathematics and (b) a constructivist approach to learning and teaching mathematics.

It is hoped that mathematics is seen as a searching for pattern and order in the world, and thus viewed as a dynamic, evolving subject, and that it is understood that the learning of mathematics occurs when students are actively involved in constructing mathematical meaning for themselves through activities and discussion. Students construct their own mathematical knowledge as they engage in interpreting and making sense of their experiences. In this view, teachers are seen as facilitators of learning rather than transmitters of facts.

With such changes in emphasis in mathematics and mathematics teaching, it is appropriate that changes in assessment practices have also been called for such that assessment be carried out in a manner which reflects the mathematics that students are expected to know and use, and the way in which it has been learnt (AEC, 1991, 1994; NCTM, 1995).

Theoretical Background

In support of these new directions in mathematics, teaching, learning and assessing mathematics, many professional development opportunities have been made available for teachers at all levels in Queensland (e.g., Nisbet, Dole & Warren, 1997); but, it seems that many teachers persist in maintaining traditional environments for learning (Burton, 1993; Perry, Howard & Tracey, 1999). Their understanding of mathematics and teaching of mathematics appears to have experienced little change, as reflected in the beliefs they hold.

Recent research suggests that teachers' beliefs about their subjects and approaches to teaching are closely related to classroom practice. Teachers' beliefs influence the likelihood of their implementing changes in the classroom (e.g., Ball, 1990; Thompson, 1992), and changes in teaching practice commonly reflect changes in belief structures (Cooney & Shealy, 1997). The relationship between teachers' beliefs and classroom practice is dynamic with each influencing the other. Some research indicates that teachers' practices are shaped by their beliefs about mathematics and the nature of teaching and learning (Fernandez, 1997; Hoyles, 1992; Putnam, 1992). Other research evidence suggests that changes in teachers' beliefs about teaching and learning are derived largely from classroom practice (Brosnan, 1994; Clarke, 1994). Clarke and Peter (1993), Guskey (1986), and Lubinsky and Jaberg (1997) claim that these changes are influenced by the production of valued outcomes (e.g., student learning) resulting from classroom experimentation.

The close link between beliefs and practices is also supported by Borko (1997) who claims that when teachers' beliefs are compatible with the ideas that underlie a professional development program, these beliefs support the change. Borko and Putnam (1996) note that meaningful change in one requires change in the other. The change process appears to be cyclical and gradual with both beliefs and classroom experimentation being considered as important components.

Because of the importance of teachers' beliefs and their association with classroom practice, this study examined the issue of primary teachers' beliefs, in particular those relating to teaching and assessing mathematics. The aims of the study were to test whether the structure of beliefs postulated in the literature would be confirmed by factor analysis, and to examine the influence of particular teacher characteristics on these beliefs.

Characteristics Impacting on Beliefs

This section addresses four characteristics that impact on teachers' beliefs and classroom practice, namely, gender, grade level, years of experience, and level of teacher qualification.

No substantial gender differences have been noticed in teachers' beliefs (Li, 1999); however, teachers do tend to see mathematics as a male domain – the subject being more difficult for average-achieving girls than for equally average-achieving boys (Bennett & Bennett, 1994; Li, 1999; Tiedemann, 2000). However, female teachers tend to be more student-centred and supportive of students than male teachers. Female teachers also use collaborative learning environments and class discussion more frequently (Li, 1999).

Research on the relationship between beliefs and years of teaching experiences is limited. Phillips, Fuchs, Fuchs, and Hamlett (1996), in their study of two teachers noted that the more experienced teacher created a superior learning environment and was a more careful, astute and accurate observer of students' learning. Other characteristics which predicated teachers' beliefs and practices were level of certification and grade level, particularly in the lower primary school (Buchanan, Burts, Binder, White & Charlesworth, 1998). Teachers with specific certification in the early years reported more developmentally appropriate beliefs.

Beliefs about Mathematics, and Teaching and Learning Mathematics

In line with the research on beliefs relevant to teaching and learning (Fernandez, 1997; Ford, 1994; Hoyles, 1992; Putnam, 1992), the authors decided to include in the study beliefs about the nature of mathematics, the teaching of mathematics, and the purposes of assessment. It was also decided to base the questionnaire items on the theoretical constructs found in the literature. It was considered important to develop the instrument with a solid theoretical basis, and to examine whether the data reflected the theoretical constructs.

In relation to the nature of mathematics, Ernest (1989) has identified three conceptions of mathematics (a) a dynamic problem-driven view where mathematics is a continually expanding field of human creation, (b) a static unified body of knowledge where mathematics is viewed as interconnecting structures bound together by logic and meaning, and (c) a bag of tools where mathematics is made up of an accumulation of facts, rules and skills. The items designed for the instrument reflected these three conceptions.

The mathematics-teaching literature notes essentially two schemes for classifying beliefs on teaching mathematics – a transmission approach where the teacher transmits information and rules to the students who are expected to absorb and reproduce it, and a constructivist approach in which teachers are facilitators of learning and students construct their own mathematical knowledge through interaction with the environment (Burton, 1993). A scheme by Perry et al. (1999) reflects this dichotomy, however they labeled the approaches as transmission and child-centred respectively. Another scheme (Kuh & Ball, 1986) posits four dominant views on how mathematics can be taught – content-focused with an emphasis on performance, content-focused with an emphasis on understanding, classroom-focused where the focus is on mathematical content through classroom activity, and learner-focused where mathematics teaching focuses on the learner's personal construction of knowledge. The items written for this questionnaire reflected the four-views scheme, in preference to the two-views scheme to provide opportunity for confirmation of either two or four views by the data.

Beliefs about Assessment

There is a paucity of research on what teachers believe about the purpose of assessment and how they use data they collect during the assessment process, despite the fact that much has been written about the purposes of assessment. The NCTM Assessment Standards (1995) note four purposes – promoting student growth, improving instruction, recognising accomplishments, and modifying

programs. Such purposes have two foci – teachers and learners. Clarke, Clarke and Lovitt (1990) claim that the major uses of assessment focus on three areas – teachers (to improve instruction), students (to inform them on their strengths and weaknesses), and parents (so they can give support). For this study it was decided to use a scheme similar to that by Clarke, Clarke and Lovitt, with their third area extended to become 'for accountability purposes', that is, as a tool for reporting to parents and other teachers.

The Purpose of This Study

This study examined primary teachers' beliefs on teaching, learning and assessing mathematics. In particular, it considered these research questions:

1. What is the nature of the beliefs of primary school teachers with regard to mathematics as a subject, and teaching and assessing mathematics? Specifically, does the structure of teachers' beliefs systems correspond to that postulated in the literature?
2. How are specific teacher characteristics, such as gender, years of experience, grade level and qualifications related to these beliefs? In other words, what differences in beliefs exist between male and female teachers, and across years of experience, grade levels and the range of qualifications?

Method

Many investigations of the relationship between teachers' beliefs and practices have been qualitative studies of a small number of teachers. However a number have been conducted using quantitative methods with large samples of teachers. This study falls into the latter category. This study was conducted by questionnaire, a method appropriate for investigating the link between assessment and instruction (Clarke & Stephens, 1994). However, one of the limitations of the survey method is the reliance on self-reporting, so cognisance is given to this in the interpretation of the results.

Instrument

A 56-item Likert-scale survey was designed for a large comprehensive study. The questionnaire consisted of five sections relating to beliefs about mathematics, beliefs about teaching mathematics, beliefs about the purposes of assessment, beliefs about the nature of assessment, and assessment practices. The questions were based on current literature in these areas (Ernest, 1989; Kuhs & Ball, 1986; Clarke, Clarke & Lovitt, 1990) as discussed earlier in the theoretical background. Teachers were asked to respond on a 5-point Likert scale (5 = very often; 4 = often; 3 = sometimes; 2 = seldom; 1 = almost never). This paper reports on the first four sections of the survey (46 items). The teachers were also asked to indicate their gender, year level they taught, level of qualification in mathematics (Year 10, Year 12, teacher education course in mathematics, University mathematics) and years of experience in teaching (0-5 years, 6-10 years, 11-15 years and >15 years).

Participants

Fifteen hundred survey forms were sent to a random selection of grade 1-7 teachers representing different grade levels (lower, middle and upper primary), school systems (government and catholic), socio-economic areas (high and low), and geographic locations (metropolitan, provincial, and rural). Although the return rate was low, (27%, $n = 398$) the resulting sample was representative of all four attributes. A comparison between the geographic regions of the respondents and the Australian Bureau of Statistics 1998 census data indicated that the sample reflected fairly closely the population of Queensland in terms of socio-economic profile and locality. The returned surveys also reflected a reasonably well-balanced distribution of grade levels in the overall sample (see Table 1).

Table 1
Percentage distribution of teachers by school grade level

	Grade Level						
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7
Percentage	13.6	14.7	15.7	12.3	12.1	11.1	17.0

Note: Teachers in grades 1 to 7 accounted for 96.5% of the sample. The balance (3.5%) of the teachers in the sample identified themselves as pre-school or secondary teachers.

Results

The responses to items relating to beliefs about mathematics, teaching mathematics, and purposes of assessment were subjected to a factor analysis, yielding 15 factors with eigenvalues greater than 1. Given the exploratory nature of the study and guided by the interpretability of the factors, a seven-factor orthogonal solution was accepted after the extraction of principal components and a Varimax rotation. The solution accounted for 41% of the variance, and 31 of the 56 items were used to delineate the factors. The naming of factors was guided by the nature of the items associated with each factor. The factors generated are as follows: Factor 1: Assessment is used to inform the teacher; Factor 2: Assessment is used to inform the learners; Factor 3: Assessment is used for accountability purposes; Factor 4: Static view of mathematics; Factor 5: Mechanistic view of mathematics; Factor 6: Traditional view of teaching mathematics; and Factor 7: Contemporary view of teaching mathematics. The first three factors relate to beliefs about uses of assessment, the next two concern views of the subject mathematics and the last two factors relate to beliefs about teaching mathematics. These sets of factors are now discussed in turn. The composition of the factors relating to beliefs about the uses of assessment is detailed in Table 2.

Table 2
Factors related to assessment

Item	Item description	Loading
Factor 1: Assessment is used to inform the teacher.		
I use assessment to:		
36j	help me evaluate how effective my teaching has been	0.75
36f	judge how well the class is progressing	0.72
36e	help me identify students with problems	0.69
36g	help me plan the next phase in teaching	0.68
36i	inform me about the ability levels of the students	0.65
Factor 2: Assessment is used to inform the learners.		
I use assessment to:		
36a	inform the students about what they do not know.	0.75
36c	encourage students to learn their work.	0.75
36d	provide information for successful students.	0.70
36h	to inform me about which students are working.	0.56
36b	give students feedback on their strengths and abilities.	0.55
Factor 3: Assessment is used for accountability purposes.		
28	The main reason why I assess student performances is to inform parents.	0.76
35	The main reason why I assess is to meet the school's requirements.	0.68
37	I tend more to test rules and facts than have students solve problems.	0.35

These three factors indicate that beliefs about the uses of assessment fall into three main categories - to inform the teacher, to inform the learners, and for accountability purposes. The factors correspond closely to the three focus areas proposed by Clarke, Clarke and Lovitt (1990). The first factor is essentially about teachers evaluating their teaching, and reflects feedback and planning components, corresponding to two of the purposes of assessment stated in the NCTM Standards (NCTM, 1995), namely, improving instruction and modifying programs. The second factor supports the notion of assessment promoting student growth, recognising accomplishments, and giving feedback on students' strengths and weaknesses. It was noted that although the item 36a (informing students about what they do not know) loaded onto Factor 2, two other items related to giving students feedback about their weaknesses failed to load onto this factor. There also seems to be a component that views students' learning and achievement as closely linked to their work ethic ('I use assessment to inform me about which students are working'). Of interest is the inclusion of 'I tend more to test rules and facts than have students solve problems' in the third factor. This may imply that if teachers are assessing for an outside audience, it is easier for them to justify rules and facts than problem solving.

Table 3 summarises the results for the factors pertaining to beliefs about mathematics (Factors 4 and 5) and beliefs about the teaching of mathematics (Factors 6 and 7).

Table 3
Factors related to views of mathematics and teaching mathematics

Item	Item description	Loading
Factor 4: A static view of mathematics		
2	The good thing about mathematics is that it is an unchanging subject.	0.83
3	The advantage of mathematics is that things are either right or wrong.	0.70
15	Today's mathematics is no different from mathematics of long ago.	0.41
1*	Mathematics is dynamic. It is a searching for patterns in the environment.	-0.35
26	Students learn best by doing lots of exercises and practice.	0.34
Factor 5: Mechanistic view of mathematics		
19	Mathematics is essentially about computation.	0.62
20	The problem with low achieving students is that they don't learn the rules.	0.57
11	It is important that students use the rules learned to get answers & solve problems.	0.50
Factor 6: A traditional view of teaching mathematics		
14	The main tools I use for gathering data are timed tests rather than projects and investigations.	0.75
34	It is difficult to plan for hands-on experiences in mathematics lessons.	0.68
9*	In mathematics I teach interesting things about the world outside school.	-0.56
Factor 7: A contemporary view of teaching mathematics		
17	It is important for student to use concrete materials in mathematics.	0.69
16*	What I teach in maths should have little to do with students' out of school life.	-0.67
5*	It is not worth spending time on collecting observational data on students.	-0.55
10	Students learn better through solving problems in real world contexts.	0.52
6	Students who do well on standard exercises don't necessarily do well on tests.	0.45
7*	Students are encouraged to explain their ideas and teach each other.	-0.36
33*	It is very important that children get the right answers to exercises.	-0.32

Note: * indicates items with negative loadings.

Factors 4 and 5 showed that the beliefs about mathematics fell into two broad categories – a static view of mathematics, and a mechanistic view of mathematics, reflecting two of the three views proposed by Ernest (1989). The items written to reflect the third view, that mathematics is dynamic and problem-driven, did not form a separate factor. The beliefs about teaching mathematics also fell into two broad categories – a traditional view and a contemporary view. The traditional view reflects a classroom environment that is dominated by timed tests, with little hands-on experience and little consideration of the relationship between mathematics and the real world. The contemporary view reflects a classroom environment rich in hands-on experiences, and students explaining ideas to each other and exploring problems related to the world outside. These results support a two-views scheme of teaching mathematics (as proposed by Burton, 1993 and Perry et al., 1999) rather than a four-views scheme (Kuh & Ball, 1986).

To gain some insight into how the sample responded overall to each of the factors, the average mean responses was calculated for the items that contributed to each factor. In the case of items that contributed negatively, the mean response was converted by subtracting the mean from 5. Table 4 summarizes the average mean frequency for each factor together with the range of mean frequencies for the items in each factor.

Table 4
Average mean frequency of responses to each factor

Factor	Average mean response	Range of item mean frequencies
Factors about assessment		
1. Assessment is used to inform the teacher	4.11	3.92 – 4.36
2. Assessment is used to inform the learners	3.39	3.13 – 3.90
3. Assessment is used for accountability purposes	2.42	2.32 – 2.67
Factors about mathematics		
4. A static view of mathematics	2.36	1.91 – 3.17
5. Mechanistic view of mathematics	2.53	1.98 – 3.48
Factors about teaching mathematics		
6. A traditional view of teaching mathematics	2.41	2.11 – 2.54
7. A contemporary view of teaching mathematics	3.16	0.82 – 4.56

Note: Responses are based on a 5-point Likert scale: 1 is low and 5 is high.

These results indicate that overall, teachers emphasise the use of assessment to inform their teaching. Next, they use assessment to inform students about their learning, and lastly, they use assessment for accountability purposes. In regard to views of mathematics, neither the static view of mathematics nor the mechanistic view of mathematics rated highly, however the mechanistic view was stronger than the static view. Regarding views of teaching mathematics, the contemporary view rated more highly than the traditional view.

Teacher Characteristics and their Influence on Teachers' Beliefs

Data were collected on four teacher characteristics, namely, years of teaching experience, gender, level of mathematics qualification, and school year level. One-way analyses of variance, Scheffe pair-wise comparisons and linear contrasts were performed in order to see if the seven belief factors varied according to these characteristics.

Years of experience was not a significant variable for any of the factors, suggesting that teachers' beliefs about teaching mathematics are not significantly influenced by the number of years a teacher has been teaching.

Gender, however, was significant for two of the seven factors – Factor 1, Assessment is used to inform the teacher ($t_{315} = -4.6, p = .000$) and Factor 2, Assessment is used to inform the learners ($t_{315} = -4.7, p = .000$). In both cases the mean factor scores

for female teachers (.128 and .078 respectively) were significantly higher than for male teachers (-.507 and -.310). Female teachers in this study clearly placed more emphasis on using assessment to inform the teacher and learners than did male teachers.

With regard to mathematics qualifications, there were significant differences for Factor 2 - Assessment is used to inform the learners ($F_{(3, 310)} = 2.75, p = .043$). To examine these difference across the four levels of qualifications (Year 10, Year 12, teacher-education mathematics, University mathematics) Scheffe pair-wise comparisons were performed. The results of this analysis showed no clear trend and no discernable pattern.

Grade level showed significant differences (at the $p = .05$ level) for four of the factors – Factor 1, Assessment is used to inform the teacher, ($F_{(6, 305)} = 23.66, p = .00039$), Factor 3, Assessment for accountability ($F_{(6, 305)} = 2.27, p = .037$),

Factor 4, A static view of mathematics ($F_{(6, 305)} = 3.35, p = .003$), and Factor 6, A contemporary view of teaching mathematics, ($F_{(6, 305)} = 23.57, p = .0004$).

Regarding the two assessment factors, the linear-contrast analysis indicated that grade level had a significant linear term for Factor 1. Using assessment to inform the teacher was emphasised more in the lower grades than in the upper grades (see Table 5). The results of the Scheffe analysis for Factor 3 indicated that there was no trend and no discernable pattern.

Grade level also showed differences in Factor 4. The results of the Scheffe analysis indicate that the static view of mathematics is more prevalent in the upper grades, especially Grades 5 and 6, and less common in the lower grades (see Table 5).

Grade level again showed differences in Factor 6. The linear-contrast analysis indicated that the contemporary view of teaching mathematics was more prevalent in teachers of the upper grades than those in the lower grades (see Table 5).

Table 5
Factor scores for Factors 1, 4 & 6 showing trends across the seven primary grades

Factor	Grade level							Trend
	1	2	3	4	5	6	7	
1. Assessment is used to inform the teacher	.18	.27	.13	.04	-.19	-.16	-.18	Decreasing
4. A static view of mathematics	-.32	-.15	-.22	.18	.38	.34	.00	Increasing
6. A contemporary view of teaching mathematics	-.29	-.11	-.14	.10	.11	.28	.18	Increasing

Discussion

This study has provided significant evidence for the structure of teachers' beliefs relating to mathematics, and teaching and assessing mathematics as proposed in the literature.

Firstly, the results confirm the three purposes of assessment as proposed by Clarke, Clarke, and Lovitt (1990) with a modification of the third area to include the school as a whole along with parents as parties external to the classroom. Clearly, for primary teachers, the notion of accountability does include a sense of responsibility to the parents of their pupils and to their colleagues in the school. Although the three assessment factors obtained do not correspond with the four purposes of assessment outlined by the NCTM (1995), those four purposes can be merged to form two of the factors obtained in this study – to inform the teacher and to inform the learners. The fact that the three assessment factors obtained in this study contributed the major portion (24% out of 41%) of the variance explained by the solution, indicates that assessment is a major issue for these teachers. The fact that the teachers rated informing the teacher the highest among the three factors indicates that the data gained through assessment is important to teachers in evaluating their personal performance.

The results showed that beliefs about the nature of mathematics reflect two of Ernest's (1989) three categories of views of mathematics. Missing from the solution is the dynamic problem-driven view of mathematics. The reason is probably that it is not a separate construct for these teachers, rather than the nature of the items. Further investigation is required to test the hypothesis. This deficiency is a major concern for mathematics educators as the dynamic problem-driven view of mathematics has been emphasized in curriculum documents and the literature for many years. If primary teachers do not identify with this view, it is unlikely that their mathematics teaching would reflect it, given the close relationship between teachers' beliefs and practice (Ball, 1990; Thompson, 1992). This issue should be addressed in professional development programs. Hopefully, when teachers start adopting a problem-solving approach and observe its advantages they may become more aware of this view. As Borko and Putnam (1996) noted, changes in beliefs and practice go hand in hand.

With regard to beliefs about teaching mathematics, the results of this study suggest that teachers' are either traditionalists with a transmission approach, or they have been convinced of the merits of the contemporary (constructivist) approach. Although support for the contemporary view was slightly higher than for the traditional view, it is of concern that in some classrooms, the teaching of mathematics occurs in a sterile environment with little use of hands-on experiences and limited attention given to relating mathematics to interesting ideas in the world.

It is interesting to note that of the four teacher characteristics examined, only two – gender and grade level – showed any significant patterns in relation to the factors identified in the study. Years of experience and levels of qualifications in mathematics had no significant associations with any of the seven factors, which is quite disturbing especially for the former - years of experience. Perhaps this is a symptom of the lack of an organised system of ongoing professional development in the state to assist teachers to upgrade their knowledge and skills. With respect to

the latter, one might expect that qualifications in mathematics education would be more influential than qualifications in mathematics. This issue needs further study.

Although the results on gender indicate a gender difference in two of the three assessment factors, the role of gender in the purposes of assessment is not very clear. Male teachers' scores on using assessment to inform the teacher and to inform learners were lower than female teachers' scores, but it is difficult to conjecture just what impact this has on the classroom. Perhaps male teachers are missing many opportunities to improve their own performance and their students' achievement levels.

The results concerning grade level indicate that using assessment to inform the teacher decreases as the grade level increases. This could be related to the gender effect just described, because male teachers tend to teach more in the upper grades than the lower grades.

The upward trend in the static view of mathematics with increasing grade level is difficult to explain as is the increasing trend in the contemporary view of teaching mathematics. What seems to be happening is that as the belief about creating an environment that uses materials, encourages classroom discussion, and explores and solves real-world problems becomes stronger, so does the belief that mathematics is an unchanging subject in which things are either right or wrong. An examination of the types of tasks chosen by teachers may give further insight into the interplay between these factors. Is there an increasing reliance on real-world related tasks that require one answer rather than the use of open-ended tasks?

Another issue arising from the results is how one can reconcile the upward trend in the contemporary view of teaching with the increase in grade level and an insignificant gender effect in teaching mathematics, with the claim by Li (1999) that female teachers are more likely to promote more collaborative learning environments. Such a learning environment reflects a contemporary view of teaching. This issue and Li's claim, requires further study.

Conclusion

This research has delineated some of the beliefs held by primary school teachers with regard to mathematics, teaching mathematics and the purposes of assessment, and has clarified the structure of those beliefs with respect to the relevant theories in the literature.

Firstly, in regard to beliefs about the subject mathematics, it seems that primary teachers hold limited views of what mathematics is – static and mechanistic views, rather than the view as a dynamic problem-driven ever-expanding field of human creation (a view more aligned with the constructivist model of learning) - and this impacts on their approach to teaching.

Secondly, the factors relating to teaching mathematics seem to reflect the types of environments mathematics teaching tends to occur in - a traditional environment with tasks unrelated to the real world and few concrete materials, and a contemporary environment where hands-on materials are valued, mathematics is related to out-of-school experiences and problem solving is encouraged. Although the average responses to the contemporary-view items were slightly higher than those to the traditional-view, the static and mechanistic views of mathematics were

noted in preference to the problem-driven view. One imagines that it would be difficult to assist teachers to be more constructivist in their understanding of learning and teaching unless their beliefs about the nature of mathematics are challenged and broadened. The implications for professional development are significant.

Thirdly, with regard to assessment, although it seems that teachers in general consider assessment important for evaluating their teaching and their students' progress, one suspects that the mathematics curriculum is assessment driven. Further, one wonders how much influence external parties such as parents have on teachers' beliefs about assessment practices and the choices teachers make on how to assess learning. These issues require further study.

Given the close relationship between beliefs, classroom practice and effective professional development (Borko & Putman, 1996), the topic of beliefs about mathematics, teaching, learning and assessment needs to be addressed in the planning of professional development opportunities if there is a genuine desire to change and improve classroom practice and thereby enhance students' understandings and skills in mathematics.

Finally, while the study has produced clearly-defined and interesting factors, the items could undergo further refinement and testing. The limitations of this type of survey research are well documented in the literature, however, the authors believe that this approach assists in confirming important aspects of teachers' belief structures, and describing various positions teachers take with respect to mathematics and teaching and assessing mathematics. Also, it is acknowledged that what teachers reportedly believe does not necessarily reflect their actual classroom practices. Past research has indicated that this tension usually occurs between the expression of liberal beliefs and conservative practice, rather than vice versa. Thus the responses described in this paper probably reflect a best-case scenario.

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