Teachers' Confidence and Beliefs and their Students' Attitudes to Mathematics

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This paper reports some initial results of a project that involved profiling middle school mathematics teachers and their students. Survey data concerning the teachers' confidence in relation to the mathematics topics that they teach, their beliefs about numeracy and effective teaching of mathematics, students' attitudes to mathematics, and their perceptions of the frequency of various events in their mathematics classrooms contribute to a picture of many teachers and their students working in traditional classrooms, believing in the importance of mathematics, but struggling with the conceptual demands of the subject and with finding relevance for the material.

Recent and ongoing curriculum reform in Tasmania has emphasised the importance of being numerate rather than of simply knowing mathematics. The definition that underpins the Being numerate key element of the Essential Learnings (ELs) Framework (Department of Education, Tasmania (DoET), 2002, p. 21) acknowledges the centrality of the discipline of mathematics along with the role of affect. It includes the following:

> Being numerate involves having those concepts and skills of mathematics that are required to meet the demands of everyday life. It includes having the capacity to select and use them appropriately in real life settings. Being truly numerate requires the knowledge and disposition to think and act mathematically and the confidence and intuition to apply particular principles to everyday problems.

Attitude to Mathematics and Beliefs

The term *disposition*, used in the DoET's definition, is among the many words used essentially interchangeably with attitude (Brahier & Speer, 1995) and there is a similar diversity of definitions of the construct. Common to these is the characterisation of attitude as including: an emotional element that places attitude nearer the affective than the cognitive end of the spectrum described by McLeod(1992); an impact on intention and hence behaviour (Ajzen & Fishbein, 1980); and dependence upon experience (McLeod, 1992) and beliefs (Ajzen & Fishbein, 1980). In addition, attitude to mathematics has been recognised as a multi-dimensional construct (Ma & Kishor, 1997) that includes confidence or anxiety (Ernest, 1988); liking or disliking mathematics; an inclination to engage in or to avoid mathematics; beliefs about whether one is good or bad at mathematics; and beliefs that mathematics is important or unimportant, useful or useless, easy or difficult (Ma & Kishor, 1997), and interesting or uninteresting (McLeod, 1992).

Wilkins (2000) identified positive attitudes to mathematics as vital to numeracy with its inherent emphasis on using mathematics. This view resonates with the definition of numeracy adopted in the Essential Learning Framework (DoET, 2002). It seems likely that attitude, which includes an engagement/avoidance dimension, plays a role in students' choices to study mathematics when it is not compulsory and is a likely contributor to declining enrolments in post-compulsory mathematics in many countries (Boaler & Greeno, 2000). Boaler and Greeno (2000) also noted a decline in students' attitudes to mathematics with grade level.

Ajzen and Fishbein (1980) distinguished between attitudes and beliefs according to whether or not they include an evaluative component. They regarded attitudes as either a positive or negative assessment of a psychological object, and beliefs as information, correct or otherwise, that a person has about their world. Instruments designed to measure the various dimensions of attitude, including that used in this study, typically ask for responses to statements that, according to the above definition, are belief statements. These statements are assumed to encapsulate a positive or negative evaluation of mathematics but it is acknowledged that these assumptions may be incorrect in at least some cases. For example, the belief that mathematics is easy, is typically associated with a positive attitude, but it is possible that individuals holding this belief also believe that mathematics is insufficiently challenging or even boring, and hence have a negative attitude to the subject. As Ajzen and Fishbein (1980) point out, attitude is the consequence of the entire cluster of relevant beliefs and hence it is important to base inferences about attitude on responses to a diverse of range of statements.

Confidence is a dimension of attitude to mathematics that appears to have particular relevance to teachers' practices. Among a set of beliefs that Beswick (in press) identified as crucial to secondary mathematics teachers creating classroom environments that were consistent with a constructivist view of learning was a belief that mathematics is *fun*. The notion of fun in this context is more than enjoyment of mathematics; rather, it incorporates a degree of confidence and delight in engaging in mathematics that goes beyond a utilitarian appreciation of the discipline. Such a capacity to play with mathematical ideas is dependent upon sufficient knowledge and understanding of mathematics to be able to see connections between ideas, and to imagine possible avenues for exploration. In contrast to this, there is evidence that many primary teachers are not at all confident about their mathematical ability, and that middle school teachers of mathematics lack confidence in relation to topics such as ratio and proportion which are central to the mathematics curriculum at that level (Watson, Beswick, Caney, & Skalicky, in press).

Classroom Environments

Shuell (1996) described the classroom contexts in which teachers and students operate as comprising, "social, cultural, affective, emotional, motivational and curricular factors" (p. 726). This complex milieu comprises the classroom environment. Considerable research attention has been directed, with some success, towards establishing links between classroom environment and students outcomes. Instruments developed to measure perceptions of classroom environments include the Constructivist Learning Environment Survey (CLES) of Taylor, Fisher and Fraser (1993) which was designed to measure the extent to which classroom environments could be characterised as constructivist.

The Study

Data reported here are based on initial profiles of teachers and their students involved in a three year study aimed at assisting teachers to improve the mathematical outcomes of their middle school students in the context of current curriculum developments in Tasmania. They represent baseline data on variables that the researchers believe are relevant to the aims of the larger study and which will be measured throughout the study.

Participants. Forty-two teachers and 650 students in their middle school (grades 5-8)

classes contributed data at the start of the project. The teachers and students were in nine primary, secondary, and district (K-10) schools in two rural regions of Tasmania. The teachers' gender and grade levels of their mathematics classes are summarised in Table 1.

Table 1
Grade levels taught and gender of participating teachers

	Primary	Secondary	Primary/secondary	No grade specified	Totals
Male	7	8	4	0	19
Female	10	9	3	1	23

Instruments. The teacher profile was similar to that described by Watson et al. (in press). Of particular relevance to the results reported here are Sections 3, 4 and 5, which comprised items related to the teachers': confidence to facilitate their students understanding of a range of middle school mathematics topics (13 items); beliefs about their own use of mathematics and the importance of mathematics in everyday life (11 items); and beliefs about mathematics teaching for numeracy in the classroom (14 items). Teachers indicated their responses to the items on scales that ranged from Low to High for the confidence items, and from Strongly Agree to Strongly Disagree for the other sections. In each case the responses were scored 1-5 according to the position marked on the scale, with 1 indicating the highest level of confidence or the level of agreement considered by the researchers to be most positive.

The student survey comprised mainly questions aimed at ascertaining the extent of their understanding of middle school mathematics. Of interest here are the 25 items requiring responses on 5-point Likert scales ranging from Strongly Agree to Strongly Disagree, or Never to Very Often which were scored such that 5 indicated Strongly Agree or Very Often for statements considered positive. Sixteen such items related to the students' attitudes to mathematics. Of these, two related to each of the eight dimensions of attitude to mathematics identified in the literature. A further nine items related to students' perceptions of their mathematics classroom environments with several drawn from the CLES (Taylor et al., 1993).

Procedure. The teachers completed the profile and administered the student survey to a middle school class for whom they were the mathematics teacher. The teacher profile required approximately one hour to complete with most completed under the supervision of one of the researchers in an after school meeting. Student surveys were administered by the teachers sometimes with the assistance of one of the researchers.

Results and Discussion

The mean score and standard deviation for each of the 13 scaled items on the Teacher Profile relating to confidence are shown in Table 2. With respect to the strands of the mathematics curriculum, the teachers were most confident about teaching Measurement and Space, and least confident about Pattern and Algebra. Many teachers also indicated a lack of confidence (i.e., response scored ≥ 3) in relation to fractions (36%), decimals (31%) and percent (26%). Teachers were particularly lacking in confidence in relation to Ratio and Proportion (55% of responses scored ≥ 3). These number topics are connected to proportional reasoning and constitute arguably the most crucial elements of middle school

mathematics (Sowder et al., 1998). Approximately one third of the teachers expressed a lack of confidence in their ability to make connections between mathematics and the Key Elements of the ELs and to assess the Being numerate key element against the ELs standards.

Table 2
Means and standard deviations of teachers' responses to Confidence items

Topic	Mean (n=42)	Standard deviation	Topic	Mean (n=42)	Standard deviation
Fractions	2.27	1.03	Mental Computation	1.76	0.79
Decimals	2.10	0.94	Connecting mathematics to other key learning areas	2.14	1.05
Percent	2.05	0.99			
Ratio & Proportion	2.63	1.00	Connecting mathematics to ELs key elements	2.88	1.09
Measurement	1.40	0.63			
Space	1.74	0.83	Critical numeracy in the media	2.61	1.25
Pattern & Algebra	2.20	1.08	Assessment of "Being Numerate" against the ELs standards	3.10	1.22
Chance & Data	1.83	1.14			

The mean score and standard deviation for each of the 11 scaled items on the Teacher Profile relating to mathematics and numeracy in everyday life are shown in Table 3. In both Tables 3 and 4 italicised items were scored in reverse such that for all items lower means indicate more positive responses.

Table 3
Means and standard deviations of teachers' responses to Mathematics and Numeracy in Everyday Life items

Item	Mean (n=42)	Standard deviation
1. I need to be numerate to be an intelligent consumer.	1.21	0.47
2. I am confident that I could work out how many tiles I would need to tile my bathroom.	1.29	0.67
3. I often perform calculations in my head.	1.21	0.52
4. Understanding fractions, decimals, and percents is becoming increasingly important in our society.	1.90	0.88
5. Quantitative literacy is just as necessary for efficient citizenship as the ability to read and write	1.90	0.89
6. I have difficulty identifying mathematical patterns in everyday situations.	3.83	1.29
7. Proportional reasoning is needed to understand claims made in the media.	1.87	0.98
8. Given the price per square metre, I could estimate how much carpet I would need for my lounge room.	1.44	1.00
9. Mathematics is not always communicated well in newspapers and the media.	1.98	1.02
10. I often use mathematics to make decisions and choices in everyday life.	1.36	0.58
11. I can easily extract information from tables, plans, and graphs.	1.52	0.92

None of the teachers disagreed with any of Items 1, 3, 4, or 10 and levels of disagreement were low (<8%) for Items 2, 5, 7, 8, 9, and 11 suggesting that most of the teachers felt confident about their ability to use mathematics for everyday tasks; and were convinced of the importance of being numerate. At least two thirds of them believed that understanding topics such as fractions, decimals and percent was important. Interestingly these were among the topics in relation to the teaching of which many of the teachers expressed a lack of confidence. Twenty-six percent of the teachers indicated that they had "difficulty identifying mathematical patterns in everyday situations" (Item 6), and 29% were ambivalent or in disagreement with the statement, "Proportional reasoning is needed to understand claims made in the media" (Item7).

The mean scores and standard deviation for each of the 11 items on the Teacher Profile relating to mathematics and numeracy in the classroom are shown in Table 4.

Table 4

Means and standard deviations of teachers' responses to Mathematics and Numeracy in the Classroom items

Item	Mean (n=42)	Standard deviation
1. Mathematics is computation.	2.78	1.13
2. I would feel uncomfortable if a child suggested a solution to a mathematical problem that I hadn't thought of previously.	1.57	1.02
3. Teachers of mathematics should be fascinated with how children think and be intrigued by alternative ideas.	1.64	2.78
4. Telling children the answer is an efficient way of facilitating their mathematics learning.	1.88	1.03
5. Allowing a child to struggle with a mathematical problem, even a little tension, can be necessary for learning to occur.	2.31	1.00
6. Mathematical material is best presented in an expository style: demonstrating, explaining and describing concepts and skills.	2.95	1.12
7. It is important that mathematics content be presented to children in the correct sequence.	2.69	1.17
8. Ignoring the mathematical ideas that children generate themselves can seriously limit their learning	1.79	1.09
9. Justifying the mathematical statements that a person makes is an extremely important part of mathematics	1.67	0.69
10. Effective mathematics teachers enjoy learning and 'doing' mathematics themselves	1.88	0.78
11. Mathematics would be very difficult to teach without a textbook	2.00	1.01
12. Mathematics teaching should assist students to develop an attitude of inquiry	1.50	0.63
13. Mathematics in high schools is best taught to mixed groups of abilities, at least until grade 9.	3.07	1.06
14. Often the mathematics work I do in the classroom is not relevant to the students' every day life	2.48	1.02

Twenty-nine percent of the teachers agreed with Item 1 that equates mathematics and computation, and 38% were undecided about this item. In light of this many of the more than 74% who agreed that, "Effective mathematics teachers enjoy learning and 'doing' mathematics themselves" (Item 10), may have meant that effective mathematics teachers enjoy computation. It is likely that many of the teachers had not given much thought to the

nature of mathematics.

Approximately 90% of the teachers agreed that justifying mathematical statements is important (Item 9), and that, "Mathematics teaching should assist students to develop an attitude of inquiry" (Item 12). A similar percentage indicated that students' suggesting solutions that they had not thought of would not make them uncomfortable (Item 2). The overwhelming majority (83%) of the teachers also agreed that they should be "fascinated with how children think and intrigued by alternative ideas" (Item 3), and 79% agreed that ignoring students' own mathematical ideas could be damaging (Item 8).

These results suggest that most of the teachers' mathematics classrooms were places where students are required to think and to justify their thinking, and where the teacher sought to build upon the students' current understandings. However, the responses to other items suggest that many of the teachers were uncertain about translating these beliefs into practice. More than 78% disagreed with the statement, "Telling children the answer is an efficient way of facilitating their mathematics learning" (Item 4) but only 29% did not agree that an expository style was best for teaching mathematics (Item 6) with a further 43% unsure about this item. Many teachers indicated that they were unsure (29%) as to whether it would be very difficult to teach mathematics without a textbook (Item 11) and a further 7% indicated their belief that it would be. Although the majority of teachers (57%) did not believe that the mathematics they taught was often irrelevant to their students' lives (Item 14) a further 29% were undecided about this. Forty-eight percent of the teachers were undecided about the whether or not grade 7 and 8 mathematics should be taught in mixed ability groups (Item 13), with 21% and 29% of the remainder expressing agreement and disagreement respectively.

The mean score and standard deviation for each of the 25 scaled items on the student survey are shown in Table 5. Scoring was reversed for italicised items and in this case a higher mean indicates a more positive result. More than half of the students indicated that they found mathematics an interesting subject (Item 1) and enjoyed mathematics lessons (Item 4). The vast majority (more than 80%) agreed that the mathematics that they learned at school was important in everyday life (Item 7), that the subject helped to develop their minds (Item 6), and that having good mathematics skills would be helpful in trying to get a job (Item 14). Seventy-six percent of the students indicate that the learned about things that interested them at least Sometimes (Item 24). Responses to Items 11 and 15 suggest that the majority of students (>52%) did not find mathematics too easy, and there was some indication from the responses to Item 5 that many found mathematics quite difficult. Fewer than one third agreed with the statement, "I find most problems in maths fairly easy", a further quarter were undecided, and more than 40% disagreed with the statement. Nevertheless, the responses to Items 8, 12, and 16 indicate that most were not distressed by the subject and were willing to persevere with mathematics problems. The majority (52%) also disagreed with the statement, "I don't do very well in maths".

Pearson correlation coefficients were calculated for each of the aspects of attitude and overall attitude score with grade level. Significant negative correlations were found for total attitude (-0.105), interesting/uninteresting (-0.132), engage/avoid (-0.081), and like/dislike (-0.102). The correlation for engage/avoid with grade level was significant at the 0.05-level and other correlations were significant at the 0.01-level. As grade level increased students were thus less likely to find mathematics interesting or to their liking and were less likely to want to engage in it.

Table 5
Means and standard deviations of students' responses to scaled items

Attitude Items	Mean (n=650)	Standard deviation
1. I find maths an interesting subject.	3.50	1.08
2. Other subjects are more important than maths.	3.13	0.97
3. I plan to do as little maths as possible when I get the choice.	3.42	1.20
4. I really do <u>not</u> enjoy maths lessons.	3.49	1.27
5. I find most problems in maths fairly easy.	3.22	1.07
6. Maths helps to develop my mind and teaches me to think.	3.89	1.02
7. Maths we learn at school is important in everyday life.	4.13	1.06
8. Maths makes me feel nervous and uncomfortable.	3.65	1.20
9. Maths is a dull and uninteresting subject.	3.56	1.25
10. I enjoy attempting to solve maths problems.	3.55	1.17
11. The problems in maths are nearly always too difficult.	3.59	1.02
12. I usually keep trying with a difficult problem until I have solved it.	3.66	1.09
13. I don't do very well at maths.	3.44	1.21
14. Having good maths skills will <u>not</u> help me get a job when I leave school.	4.38	0.97
15. Most of the time I find maths problems too easy and unchallenging.	2.60	1.02
16. I don't get upset when trying to work out maths problems.	3.70	1.27
Classroom environment items		
17. I try to make sense of other students' ideas about maths.	3.28	0.97
18. The activities I do in maths are set by the teacher.	1.88	0.98
19. I learn the teacher's method for solving maths problems.	2.66	1.09
20. I use equipment in my classroom to help me with my maths work (e.g. counters, charts)	2.51	1.20
21. I am asked to explain my maths thinking.	3.32	1.03
22. The teacher helps me to think about what I learned in past maths lessons.	3.28	1.09
23. I try to find my own way of solving maths problems.	3.69	1.02
24. In maths I learn about things that interest me.	3.14	1.13
25. I decide if my solutions to maths problems make sense.	3.46	1.06

Responses to the classroom environment items indicated that the students' average perception was that the teacher set the activities in mathematics. More than three quarters indicated that they tried to make sense of their peers' ideas at least some of time (Item 1). Items 19 to 25 described phenomena that quite high percentages (28%-40%) of students believed occurred Sometimes, with all but Item 20 having similar percentages who indicated that the event occurred 'Often'. Fewer than 20% of the students indicated that they used materials such as counters and charts more often than Sometimes (Item 20).

Conclusion

The baseline data reported here are consistent with Boaler and Greeno's (2000) observation that students' attitudes to mathematics deteriorate with grade level. It also provides some insight into particular aspects of attitude that decline with grade level and confirms the findings of Watson et al. (in press) regarding the lack of confidence of many

middle school teachers in relation to the mathematics content that they teach. The overall picture is of teachers beginning the three year project holding many beliefs about mathematics teaching and learning that the researchers regard as positive, but unsure as to the appropriate pedagogies to translate these into practice. This uncertainty was evidenced by the relatively large proportions of the teachers expressing ambivalence with respect to the appropriateness of expository teaching of mathematics, the importance of textbooks, and the value of streaming in grades 7 and 8. The students' indication of the rarity of the use of equipment in their mathematics classes and their perception that the teacher is very much in control of the classroom agenda also suggest that in spite of progressive beliefs many teachers and their students work in quite traditional classrooms.

It is hoped that other researchers will make use of the instruments described in order to assess their utility in measuring aspects of teachers' and students' beliefs and attitudes.

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