What do education students value in primary mathematics curriculum?

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In this paper the priorities that second year education students hold for primary mathematics content and student learning are presented. Data were collected from students who participated in a tutorial task that was used to engage students in discussion about primary mathematics curriculum. The data were collected annually for four years. Reflections about the mathematics subjects in the course are made within the context of current research and mathematics curriculum policy. Inferences are drawn about education students' beliefs.

Values and beliefs have been an on-going focus of teacher educators in their research of pre-service and in-service training and professional development of mathematics teachers (Thompson, 1992). Recent Australian studies, reviewed by Perry, Southwell and Howard (2000) have focused on teacher and trainee teacher beliefs about teaching and learning. They report that other researchers have investigated trainee teachers' knowledge of mathematics, teaching practice and programs in teacher education.

The data presented in this paper are part of my on-going evaluation of mathematics related subjects in a Bachelor of Education (P-12) course over the period 1998 - 2001. In asking the question "What do second year education students value in primary mathematics curriculum?" I was seeking to find out what mathematics my education students thought primary school students ought to learn. It is a question about curriculum content rather than one of pedagogy. When reflecting on the results I will however, make some inferences about students' views about ways of knowing mathematics and the nature of mathematics. Reflections about teaching and learning through the mathematics subjects and the practice-based component of the course, that is the school placement program called *Project Partnerships*, will be made in the context of recent research and curriculum policy in mathematics curriculum and teaching.

Background

Context

The students whose views are reported in this paper are participants in a primary and secondary education course. Within the four year program, mathematics is a substantive focus of their learning in first, second and fourth years of the course. Students in first year study *Numeracy and Mathematics*, a mathematics content based subject that aims to model good practice in teaching and to improve students' knowledge and confidence with mathematics. Students in second year study *Mathematics and Numeracy Education*, a pedagogical and curriculum based subject. The aim here is to develop students' understanding of primary mathematics curriculum, children's learning of mathematics and numeracy, and education students' teaching competencies.

Students also have substantial contact and involvement with schools through *Project Partnerships* in each year of the course (Carpenter, Cherednichenko, Davies, & Kruger, 2000). Their practice-based work includes teaching and curriculum projects negotiated with the school along with a range of other activities. Students are placed in primary schools for *Project Partnerships* in first, second and fourth year and in a secondary school in third year. In second year they are required to teach some mathematics as part of their work in primary classrooms. Some students become involved in mathematics projects that are negotiated with the school. Throughout the period of the study, only a small number of second year students have been involved in mathematics curriculum projects. Students normally worked on curriculum projects to support another key learning area. Tutorial and assessment tasks for the mathematics curriculum subject in second year are closely related to students' partnership work.

The literature

Teachers' conceptions of what mathematics is and how it should be taught are intertwined. Thompson (1992) reviewed the body of literature that explored teachers' beliefs about mathematics and their beliefs about teaching and learning of mathematics and the relationships between these conceptions. She argued that the findings were applicable to programs and research concerned with changing teachers' practice and recommended that researchers and teacher educators gain further insight into changing the beliefs and conceptions of pre-service and in-service teachers. Australian researchers have built on this research and others have examined values in mathematics education (Bishop, 2001; Perry, et al., 2000).

Primary teachers' and student teachers' beliefs are related to their past experiences of mathematics, and primary teachers' beliefs are also related to their experiences as teachers (Nisbet & Warren, 2000; Perry, Howard & Conroy, 1996; Schuck, 1996). Primary teachers appear to hold a view of mathematics as static or mechanistic, that it is unchanging about computation and concerned with rules and procedures (Nisbet & Warren, 2000). A contrary view was presented by Perry et al (1996) who found that a high proportion of primary teachers held a more dynamic view of mathematics believing it to be concerned with pattern and order comprising a way of knowing and thinking.

Both studies found evidence of some primary teachers who hold what they described as traditional views of mathematics teaching and learning. These teachers believed that primary children should be able to solve problems quickly and memorise facts and that teachers ought to transmit knowledge. These teachers did not normally include hands-on experiences or relate mathematics to everyday situations. However, these teachers were not in the majority. These studies also found that primary teachers were more likely to hold contemporary views about learning that involved student-centred and constructivist approaches to teaching.

A high proportion of teachers in the study by Perry et al (1996) agreed that learning mathematics ought to be based on experiences, interpreting the environment and taking place in a supportive environment that was problem based where children were challenged. Teachers, whom Nisbet and Warren (2000) described as holding a contemporary view of teaching, agreed that students needed to use concrete materials, solve problems in real world contexts and these teachers were less concerned with correct answers.

A study by Anderson (1998) also found that primary teachers valued problem solving. However, the majority of teachers in this study identified routine problems as the type of problems that they used in their classrooms with some teachers indicating a use of open-ended and unfamiliar problems. This study suggests that espoused beliefs and classroom practices may not be consistent or that teachers may hold more traditional views of mathematics than might otherwise be assumed.

The problem, as Schuck (1996) explains it, is that prospective primary teachers are constrained or "chained" to their beliefs about mathematics by their past experiences, their experiences in primary classrooms during their training, and by their personal goals for learning that are focused on how to be a teacher. She argues that primary student teachers in their first year of study are negative about mathematics, view mathematics as static and rule based and have limited subject knowledge. Schuck and Foley (1999) argue that mathematics teacher educators need to be interventionist when designing their programs if the chains are to be broken and all students not just the 'elite' are to have access to the power of mathematics that is socially and culturally relevant to them.

Bishop (2001) argues that mathematics values are learned and embedded in teachers' practice. He explains that "Values in mathematics education are deep affective qualities that education fosters through the school subject of mathematics. They appear to survive longer in people's memories than does conceptual or procedural knowledge" (p. 94). Drawing on previous research Bishop contends that values differ from beliefs and attitudes. For something to be a value there must be "existence of alternatives, choices and choosing, preferences, and consistency" (p. 95). Most teachers, he argues, are not conscious of the values that they carry or mediate in the classroom, but their values are evident through the decisions that they make in their practice of teaching.

Data concerning student teachers' attitudes to mathematics are not presented here. However, many first year education students that I have taught have expressed negative attitudes or related stories from their prior experiences to explain their negative views during tutorial tasks and discussion (Schuck, 1996; Biddulph, 1999). Significant proportions of my first year students also report a lack of confidence or have demonstrated through tutorial tasks limited knowledge of mathematics consistent with previous studies (Biddulph, 1999; Kaminski, 1997). In this paper, I am concerned with the decisions that prospective teachers of primary mathematics may make about mathematics curriculum, the beliefs that they indicate and how the mathematics teacher education program influences their beliefs and the decisions that they might make as primary teachers.

Evaluation

The Learning/Evaluation Activity

The activity "Mathematics Learning Outcomes" was used to generate discussion among tutorial participants about their knowledge and values with respect to primary mathematics curriculum. The activity was adapted from a professional development activity designed by the Equals Network (1989) in New Zealand for secondary mathematics teachers. It has been designed following the model of forced choice tasks for values clarification (Simon, Howe, & Kirschenbaum, 1972). The sixteen mathematics learning outcomes used in the task are listed in Table 1. They concern one or more content "strands" of the *Mathematics Curriculum and Standards Framework* (Board of Studies, 1995) including the "Reasoning and Strategies" strand, that is, working mathematically (Australian Education Council, 1990). An earlier version used in 1998 was titled "Curriculum Priorities". It included the same list of learning outcomes but they were presented in a different order. In the tutorial the students completed the following task individually:

> If you had to delete half of the following list of desirable mathematics learning outcomes, which eight would, in your opinion need to be retained? And of these eight, what would be your top four?

In the tutorial I then formed small groups and asked them to discuss and debate their choices and generate an agreed list of the groups' top four. The groups then reported their conclusions and I constructed a table to record the groups' priorities on the whiteboard.

Participants and Data Collection

I used the learning activity described above with my second year mathematics curriculum subject tutorial groups from 1998 to 2001. For 1998, 1999 and 2001 I used it in the final week of the semester (Week 13) and in 2000 close to the beginning of the semester, in Week 4. The numbers of participants in each of the tutorials are recorded in Tables 1, 2 and 3. For 1998, 1999 and 2001 the students' individual responses were collected. In 2000 only each group's top four priorities were collected.

The subject was taught on two different campuses and from 1998 – 2001 I taught it on either or both of these campuses - in 1998 and 2001 at Campus A and in 1998, 1999, 2000 and 2001 at Campus B. Students enrolled at Campus A undertake major studies in physical education, outdoor education, health, computing and, in smaller numbers, a range of other subjects alongside their required education subjects. Students at Campus B undertake major studies in English and language, computing, social inquiry, visual arts, drama and in smaller numbers a range of other studies including psychology and mathematics. There was a higher proportion of male students enrolled at Campus A than Campus B in each of the years, but the gender of the participants was not collected nor were their curriculum priorities.

The data collected individually from students only identifies the learning outcomes that they have checked for their top eight and top four. It does not include an order of priority. In the following section I report the results. Initially I focus on the results for education students in second year in 2001 for their top eight and then their top four priorities and also compare the priorities for students at the two campuses. Later I compare these results with those gathered in previous years.

Results

Eight most valued learning outcomes

In Table 1 the results for 2001 are presented for a tutorial group at each campus and for the cohort as a whole. The number and percentage of students selecting the learning outcome within their "top eight" is recorded.

The most valued learning outcomes were *solve maths problems about everyday situations* (86%), *estimating calculations and measurements* (82%), *perform basic operations without a calculator* (75%), *remember number facts* and *use their own methods to solve maths problems* (both 64%). More than half of all students included *explain their own method* (61%) and *check procedures when calculating and measuring* (54%) in their top eight, which is a higher proportion than would be expected if students'

Table 1
The eight most valued learning outcomes in 2001

Learning Outcome	Campus B (N=13)		Campus A (N=15)		Total (N=28)	
	n	%	n	%	n	%
A. Check procedures when calculating and measuring.	3	*23*	12	*80*	15	*54*
B. Solve maths problems about everyday situations.	11	*85*	13	*87*	24	*86*
C. Remember number facts.	11	*85*	7	*47*	18	*64*
D. Use a calculator.	3	*23*	1	*7*	4	*14*
E. Follow routine instructions.	2	*15*	3	*20*	5	*18*
F. Use key mathematical words.	4	*31*	5	*33*	9	*32*
G. Draw mathematical objects and situations.	3	*23*	8	*53*	11	*39*
H. Work through repetitive exercises.	2	*15*	5	*33*	7	*25*
I. Use their own methods to solve maths problems.	11	*85*	7	*47*	18	*64*

J. Spot patterns.	5	*38*	9	*60*	14	*50*
K. Remember standard methods.	5	*38*	8	*53*	13	*46*
L. Pose mathematical questions.	7	*54*	5	*33*	12	*43*
M. Describe mathematical objects and situations.	3	*23*	6	*40*	9	*32*
N. Estimate calculations and measurements.	12	*92*	11	*73*	23	*82*
O. Perform basic operations without a calculator.	10	*77*	11	*73*	21	*75*
P. Explain their own method.	8	*62*	9	*60*	17	*61*

top eight preferences had been spread evenly over the sixteen options (that is, 50%).

In general these education students' priorities fit with a valuing of numeracy outcomes within the primary curriculum. They are consistent with numeracy policy (Australian Association of Mathematics Teachers, 1997; Willis & Johnson, 1997) that forms part of the formal curriculum of the university based mathematics subjects and perhaps reflects current practice in the schools in which they undertook *Project Partnerships.*

Their priorities also suggest that these students may hold a constructivist or social-constructivist view of learning (B, N, I, P) and a valuing of problem solving (B, I, J, P). More than half the students have selected learning outcomes that suggest that they value process ahead of correct answers (A, I, N, P). It is not clear from the data, but it is possible that at the same time, students also value the correct answer in mathematics (B, C, O).

Clearly an emphasis that we placed on explaining their methods and on valuing alternate methods in first year was valued (I, P). In the second year subject we also placed an emphasis on children explaining (How did you do that?) as a means of assessing children's understanding in a way that was consistent with constructivist theories of learning and cognitively guided instruction.

It is not clear, however, whether the students interpret problems as open-ended problems, non-routine problems (possibly J) or routine word problems concerning everyday situations. Given the findings of Anderson (1998) and the influence of primary teachers (Schuck, 1996) it is likely that second year students' valuing of problem solving mirrors that of primary teachers and is focused on routine word problems.

An emphasis on number over other areas of the curriculum is evident (C, O). This result possibly reflects their experiences in primary schools and also an emphasis in the content of their university subjects. I think that it would be wishful thinking to suggest that these values might reflect a valuing of mental computation skills beyond automatic response despite the emphasis placed on this in the first year and second year subjects.

What is least valued - What would they leave out?

Outcomes to do with geometry and spatial skills (G, M), arguably the most important for survival, are the mathematics learning outcomes that were least likely to be selected by students in their top eight. I'd like to argue that this result reflects practice in schools and hence their prior experience. Space, the relevant *Curriculum and Standards Framework* (CSF) curriculum strand, receives the least formal mathematics learning time in schools. In the recently conducted *Early Years Numeracy Research Project*, Clarke (2001) reported that 20% of Grade 4 children did not identify a right angle triangle as a triangle.

The other noteworthy omission was *use a calculator*. This is in spite of considerable research that values the calculator as a learning tool in the early years of schooling and for realistic applications, and the objectives of the CSF (Asp & McRae, 2000). This result is also surprising because in the previous year when taking the first year subject the students completed an investigation about the use of mathematical skills in their own lives (a task based on the research task conducted by Northcote and McIntosh, 1999). The students reported that they used mental computation, especially for estimation, and calculators in almost equal proportions for their daily mathematical tasks, and pen and paper methods rarely. It should be noted however that the role and place of calculators in primary school raised the most vehement debate during the forum at the *Mathematics Education Research Group of Australasia's* conference in 2001. Primary teachers who are not aware of the research findings are more likely to be negative about their use (Sparrow & Swan, 1997).

Similarities and differences between Campus A and Campus B students

The results show that for the eight most valued learning outcomes the two groups of students hold similar values. A higher proportion of students at Campus A (more than 20% difference) valued *check procedures*, *spot patterns* and *drawing maths objects and situations*. Higher proportions of students at this campus also valued *work through repetitive exercises* and *remember standard methods*. These differences show that Campus A students were more likely to value shape and spatial knowledge than Campus B students, and that they also valued more highly problem-solving strategies and practice. Their values also suggest a more procedural way of knowing mathematics.

A higher proportion of Campus B students (more than 20% difference) valued *remember number facts*, *use their own methods to solve problems*, *pose mathematical questions* and *estimate*. Students at this campus also showed more support for being able to use a calculator. These differences show that Campus B students value numeracy outcomes and when taken with their other preferences suggest a preference for a constructivist way of learning and knowing mathematics.

Four most valued learning outcomes

When it came to the crunch, what did the preservice teachers value? The *number* and percentage of students selecting a particular learning outcome as one of their 'top four' outcomes is presented in Table 2 for students in second year in 2001. Note that when comparing results with those presented in Table 1, one student at each campus did not complete this task and one student at Campus A changed his/her mind between the first and second task and selected a different learning outcome in the top four.

The results show that students' priorities are not spread across all of the learning outcomes as in the previous selection. One might have expected that the percentage of students selecting four outcomes would be half that when selecting eight outcomes, however, the results show that the group as a whole has focused their priorities more keenly when the number of options was limited to four.

Three of the learning outcomes with the highest proportion of students selecting them are common in both sets (top 8 and top 4). These are *solve maths problems about everyday situations* (81%), *estimate calculations and measurements* (73%) and *perform basic operations without calculators* (62%). There are no surprises here: a mix of a contemporary focus on problem solving and numeracy, and the traditional pen and paper number skills. The differences between campuses as discussed above are also evident in these data. What becomes more apparent from these data is the valuing of problem-solving skills by Campus B students.

What gains value?

Explain their own method moved from the 6th most valued learning outcome to the 4th most valued learning outcome when students had a more restricted number of choices (42% instead of the expected 30%). *Explaining* appears to be especially valued by students at Campus B. *Remember standard methods* moved from being rated 9th most valued to 5th most valued learning outcome (35% instead of the expected 23%). Students at Campus A more strongly valued remembering standard methods.

What loses value?

Remember number facts falls from its overall ranking of 4th most valued learning outcome to 8th most valued (15% instead of the expected 32%). *Use their* own *methods* also falls in value. Instead of the 4th most valued learning outcome it remains important but now is the 7th most valued (31% instead of the expected 32%).

Table 2
The four most valued learning outcomes in 2001

Learning Outcome	Campus B (N=12)		Campus A (N=14)		Total (N=26)	
	n	%	n	%	n	%

A. Check procedures when calculating and measuring.	2	*17*	6	*43*	8	*31*
B. Solve maths problems about everyday situations.	7	*58*	14	*100*	21	*81*
C. C. Remember number facts.	4	*33*	0	*0*	4	*15*
D. D. Use a calculator.	0	*0*	0	*0*	0	*0*
E. Follow routine instructions.	1	*8*	0	*0*	1	*4*
F. Use key mathematical words.	0	*0*	0	*0*	0	*0*
G. Draw mathematical objects and situations.	0	*0*	3	*21*	3	*12*
H. Work through repetitive exercises.	0	*0*	0	*0*	0	*0*
I. Use their own methods to solve maths problems.	5	*42*	3	*21*	8	*31*
J. Spot patterns.	0	*0*	2	*14*	2	*8*
K. Remember standard methods.	3	*25*	6	*43*	9	*35*
L. Pose mathematical questions.	0	*0*	2	*14*	2	*8*
M. Describe mathematical objects and situations.	0	*0*	0	*0*	0	*0*
N. Estimate calculations and measurements.	11	*92*	8	*57*	19	*73*
O. Perform basic operations without a calculator.	7	*58*	9	*64*	16	*62*
P. Explain their own method.	8	*67*	3	*21*	11	*42*

What is most surprising here is that students would value remembering standard methods ahead of number facts. It suggests that they value a transmission model of teaching mathematics rather than a model of teaching that would value and promote developing number sense based on acquiring and using number facts. Number facts are part of the early years' mathematics curriculum and important in developing number sense. It is unclear how the implementation of the Victorian *Early Years Numeracy Project* (Department of Education, Employment and Training, 2001) will impact on students' values. There is a strong emphasis in this published material on constructivist ways of learning and knowing, cognitively guided instruction and the use of open-ended tasks.

A valuing of efficient number strategies is not as strong in the Victorian materials as it is in the New South Wales program *Count Me In Too* (Department of Education and Training, 2000). It is likely that students may not appreciate the role of number facts in estimation and mental computation unless we continue to emphasise this link. An emphasis on using alternate methods through the use of open-ended tasks that enable children to engage and respond using different strategies and levels of knowledge in the *Early Years Numeracy Project* material may see this learning outcome become more valued by our students.

Four most valued learning outcomes 1998 – 2001

Second year students' values about primary school mathematics curriculum appear to have been fairly consistent over the last four years. In Table 3 the results for the top four most valued outcomes are displayed for 1998-2001. The percentage of students selecting a learning outcome in their 'top four' is displayed for 1998, 1999 and 2001. Individual student's preferences were not gathered in 2000. Instead, a summary of the whole tutorial group's priorities was collected and these data are presented in Table 3. A rank score is used to show the order of frequency of learning outcomes that were selected in a group's 'top four'.

Table 3
The four most valued learning outcomes 1998 – 2001

Learning Outcome	1998 Campus A&B (N=31) %	1999 Campus B (N=50) %	2000 Campus B Rank[a]	2001 Campus A & B (N=26) %
A. Check procedures when calculating and measuring.	16	36	*3*	31
B. Solve maths problems about everyday situations.	77	76	*1*	81
C. Remember number facts.	19	22		15
D. Use a calculator.	3	8		0
E. Follow routine instructions.	23	8		4
F. Use key mathematical words.	16	18		0
G. Draw mathematical objects and situations.	6	12		12
H. Work through repetitive exercises.	3	10		0
I. Use their own methods to solve maths problems.	16	38		31
J. Spot patterns.	16	4		8
K. Remember standard methods.	29	12		35
L. Pose mathematical questions.	6	14		8
M. Describe mathematical objects and situations.	13	2		0
N. Estimate calculations and measurements.	16	24	*3*	73
O. Perform basic operations without a calculator.	81	22	*2*	62

P. Explain their own method.	58	44	*3*	42

[a] An equal number of groups selected A, N & P in their 'top four' and these learning outcomes were equal third in the tutorial groups' priorities.

In1999 and 2001 *solve maths problems about everyday situations* was valued in the top four by the highest proportion of students (76% and 81% respectively). It rated second highest in 1998 (77%). In 1998 *perform basic operations without a calculator* was valued in the top four by the most students (81%). While this learning outcome was strongly supported by students in 2001 (62%), only 22% valued it in their top four in 1999.

The largest shift or increase in value from 1998 - 2001 was for *estimate calculations and measurements* (16% in 1998 to 73% in 2001). It is unclear why. Perhaps the results of their numeracy investigation in first year had some sort of impact for the 2001 students. Perhaps there has been a significant shift in primary schools to teach estimation strategies. It remains to be seen whether this learning outcome will also be valued by the next years' group of students.

Explain their own method shows a decreasing percentage of students valuing this outcome over the four-year period, though it has remained a high priority. *Use their own methods to solve maths problems* and *check procedures* were more strongly supported by students in 1999 than for other years. While it was of lesser importance than these other outcomes, a higher proportion of students also valued *use key mathematical words* in 1998 and 1999 than in 2001.

The oscillating results for *perform basic operations without a calculator*, *remember standard methods*, *check procedures* and *use their own methods* probably had more to do with the differences between the students at Campus A and Campus B, than fluctuations in values over time. As noted earlier, students at Campus B appear to more highly value learning outcomes associated with constructivist views of learning, whereas students from Campus A appeared to more highly value traditional or conservative views of teaching and procedural ways of knowing.

In 2000 only data for group responses were collected. This occurred in the fourth week of the semester. The ranks shown in Table 3 indicate that the values of these students from Campus B were very similar to those of students in other years. This finding demonstrates that students' values about primary mathematics curriculum are already in place prior to commencing study of the mathematics curriculum subject in the second year of the course. It suggests that students' values were based on their previous experience of mathematics in their own schooling and their conceptions about mathematics. It is possible, however, that the education students' values were influenced and perhaps even confirmed by their experiences of the mathematics subject in first year and their experience of primary classrooms in their first year of *Project Partnerships*.

Discussion

The second year students in my tutorial groups over a period of four years have consistently placed a priority in primary students learning to *solve mathematics problems about everyday situations*. These values are consistent with the primary objectives of mathematics curriculum policy. To leave it there though, may be to ignore a particular belief that intending primary teachers may hold about the nature of mathematics, that it is essentially utilitarian. Certainly of less importance, to these groups of students, were the numeracy concepts that underpin primary students' future learning of mathematics in secondary and further education. An alternate view of the nature of mathematics may have been presented had students selected learning outcomes such as *spot patterns*, *use key mathematical words* and *draw mathematical objects and situations*.

Mathematics in everyday situations. It is not clear from the task used in this evaluation what the students interpreted as mathematics problems in everyday situations. Further clarification with students of their understanding of problems in everyday contexts is needed. It seems likely that students may value routine word problems over 'messy' real problems that engage them in thinking mathematically (Trafton, 1999). Furthermore, the recent research by Cooper and Dunne (2000) ought to be part of the students' inquiry about this strongly held curriculum value. Cooper and Dunne investigated the performance of working class students on mathematics problems in everyday situations used in a national testing program in the UK. These students throughout their years of training and perhaps in their professional lives will work in schools with a high proportion of students from a low socio-economic background. Cooper and Dunne showed how children from working class environments are disadvantaged by the discourse of 'real life' mathematics. It is therefore necessary that our students develop a sophisticated understanding of problems in everyday situations, the mathematical discourse associated with them and the teaching strategies required for particular cohorts of students, perhaps quite similar to themselves in the way that they have been previously alienated from mathematics.

Geometry. Concepts and skills concerning shape, spatial visualisation, location and visual strategies for solving mathematics problems were not valued by many students. This finding perhaps reflects weaknesses in their own knowledge (at least one third of first year students displayed weaknesses in this area when tested in 2001 and in previous years). It almost certainly reflects the relative absence of this mathematics field of knowledge in primary and secondary curricula revealed by other researchers and the lack of research emphasis by mathematics education researchers in this field. There was a stronger emphasis on shape, spatial visualisation and location in first year content and assessment tasks in 2001 and it will be interesting to see if the results change. We could also devote more time to this topic in second year.

Calculators. The views of our students reflect the views of teachers revealed in other research studies. The use of and the teaching of the use of calculators raise dilemmas for teachers. We do need to improve the sessions conducted on the use of technology and calculators in the second year subject. As well as integrating the use of technology into inquiry about children's learning of mathematics within the program we need to acknowledge conflicting values. Activities that are designed to assist our students to clarify their values concerning technology in mathematics, and reflect on practice and student learning could be included in the second and/or fourth year subjects.

Standard pen and paper algorithms vs mental computation. It is unclear exactly where my students stand on this debate. Their own experience ought to lead them to valuing mental computation and the use of estimation (that they do value). However, the focus in primary schools on mental computation is still limited as revealed by poor achievement in recent Australian research (Callingham & McIntosh, 2001). The number curriculum is dominated by standard pen and paper algorithms for whole number, especially from Year 2 to Year 4. International research suggests that primary students may usefully benefit from a curriculum that focuses on number sense and mental computation strategies rather than standard algorithms (Buys & Neuman, 2001; van den Heuvel-Panuizen, 2001).

Campus A versus Campus B. What factors may be influencing the differences between Campus A and Campus B? Gender difference in enrolments is the most obvious, but gender factors may be complicated by differences in curriculum and learning interests. Previous research has shown female primary teacher to be more student-centred than male teachers (Li, 1999). Such a belief might be held by Campus B students given their higher valuing of primary students being able to use their own methods to solve maths problems. Perhaps students at Campus A have had more teaching experiences in Year 5 or 6 classroom. Primary teachers of these grade levels are more likely to hold a static view of mathematics than teachers of other grades (Nisbet & Warren, 2000). Or perhaps the previous mathematics experiences of these two groups of students are different. Do the Campus A students have a higher participation in VCE mathematics? Do the Campus B students come from schools with a higher level of social disadvantage with poorer VCE mathematics participation and outcomes?

A new instrument. It may be useful to change the list of outcomes to see if a more explicit reference to pen and paper methods and mental computation makes a difference or is more revealing about their values regarding number learning. The learning outcomes could also differentiate the types of mathematics problems encountered in everyday situations. It would also be worthwhile replacing the word *calculators* with *technology*.

Conclusion

I've found that the task that has been discussed in this paper effectively generates discussion among teacher education students about primary mathematics curriculum and the values that they hold. While some groups choose just to vote to find the top four learning outcomes, other students are quite surprised by the differences in their views and argue ardently for their point of view. The discussion by the students is the reason that I continue to use the task. Bishop (2001) argues that there is an assumption that the values espoused in curriculum documents are to be gained through the process of learning mathematics. He proposes that values be treated as part of the content if we are to educate future citizens for our democratic societies. The data presented in the current evaluation supports a more concerted effort to address values within the mathematics-related subjects in teacher education and pre-service teachers' activities in schools.

Pre-service teachers make, and observe other teachers make, decisions about what will be taught and how, and make decisions when negotiating meaning with students in the interactions in their classrooms. Their critical inquiry about practice ought to include reflecting upon the mathematics values that children have learned as a result of these decisions as well as reflecting on the children's learning of concepts and skills. Awareness of conflicting mathematical values as well as children's misconceptions of content and skills may encourage pre-service teachers to rethink and change their practice.

The findings of this evaluation also suggest that as teacher educators we need to engage with our colleagues in schools about what we value in mathematics curriculum to improve practice and children's learning. The degree program in which the current evaluation was conducted is strongly practice-based, however, explicit discussion about mathematics learning, teaching and curriculum between mathematics educators and *Project Partnerships* teacher mentors is minimal. We need to develop creative ways to collaborate within the *Project Partnerships* including the negotiation or more mathematics curriculum projects.

Making a difference to what teacher education students' value is difficult. Subtle changes are worthy of further inquiry. Others have noted that teachers' values are strongly related to their experiences as learners, but they are also related to their experiences as teachers (Bishop, 2001; Nisbet & Warren, 2000; Schuck, 1996). The values that students disclose in second year of the course investigated in this paper need to be subjected to further critical inquiry through the *Project Partnerships* and the mathematics related subject in fourth year.

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