

CHALLENGING PRIMARY STUDENT TEACHERS' VIEWS ABOUT MATHEMATICS EDUCATION

FRED BIDDULPH
University of Waikato

This year a large group of first-year student teachers at the University of Waikato began their introductory mathematics education course by each interviewing a five-year-old child in a school. During the interview they explored the child's understanding of number and the intellectual strategies used by the child to generate such understanding. Data from an investigation into the effects of this approach show that it took most student teachers by surprise and changed the views of many about how children learn in mathematics and about the teaching role. The more important of these changes are outlined in the paper.

INTRODUCTION

As in a number of other countries (see, for example, Nisbet, 1991) a proportion of students entering the primary teacher education programme at the University of Waikato lack confidence in their own understanding of mathematics, mostly because of negative experiences in the subject while at school. Some are understandably anxious about what the first mathematics education course holds for them.

Other students have left school with their confidence reasonably intact, but from their own classroom experiences as learners of mathematics many appear to have gained a narrow reception/transmission view of learning and teaching in mathematics, a view which is inappropriate to mathematics education today.

For these reasons we have, like some other mathematics teacher educators (for example, Crawford, 1991; Klein, 1991) taken innovative measures to try to address these issues. In particular we have developed an introductory course which is non-threatening but designed to quietly challenge traditional beliefs about learning, teaching and mathematics itself. The initial focus is on young children, in particular their number ideas and associated intellectual strategies. After six hours of introductory work, students visit a local school where they each interview a five-year-old child twice, one week apart. In between visits, and following the second, they share and discuss their interviewing experiences in tutorial-type settings.

To facilitate the interviewing process, the author this year devised a new interview schedule, a copy of which is issued to each student. They spend most of the first six hours of the course in workshops becoming familiar with the schedule, making resources to use with it, and developing interviewing skills. An initial session is also spent exploring the various intellectual strategies the student teachers themselves use in performing common operations such as multiplication.

Central questions for the author were whether the early use of the new interview schedule would influence the student teachers' (a) attitudes toward and perspective about mathematics, and (b) their views about learning and teaching in mathematics. This paper reports the results of an investigation into these questions with the first cohort of student teachers to use the new interview schedule.

THE INTERVIEW SCHEDULE

The interview schedule was constructed with four principles in mind:

1. It should involve the children in number tasks set in contexts that are likely to be meaningful to young learners;
2. It should allow a range of understandings to be revealed;
3. It should be structured in a way that is non-threatening to children - hence the inclusion of interviewing techniques;
4. It should, as far as is possible with young children, allow their intellectual strategies in the area of number to be identified.

The number tasks probed children's familiarity with number ("I was wondering if you had a favourite number?") and a calculator, their ability to rote count and count meaningfully, their understanding of the cardinal and ordinal value of number ("Could you hide this 'treasure' under the 4th 'cushion'?"), numerals ("Could you put something on the envelopes to show how many zoo tickets are inside them? The numbers have fallen off my ruler/clock; could you help me put them back on in the right places?"), and the four operations ("Could you share out these 'chips/French fries' so that I get the same as you?"), measurement, and graphing ("using a pictograph of 'pets'").

DATA COLLECTION

Data were collected, by way of an open-ended questionnaire, from 102 student teachers undertaking the course in the first semester of their first year of study. They were asked (a) whether they expected to begin the course by interviewing a child, (b) what aspects of working with the child proved a challenge, and (c) whether the interviewing experience influenced their ideas about both how children learn and teaching mathematics. This questionnaire was administered within one week following the second interview. Further data were obtained from examining the interview-related log-book entries of a sample of 41 student teachers from the above group. These entries included the student teachers' reflections about the impact of the interviewing experience on their thinking about learning and teaching.

RESULTS

For nearly three-quarters of the student teachers (74), interviewing a child early in the course was quite unexpected. Typical responses were: "It took me completely by surprise." "It was quite a shock." "I didn't think we would be let loose [on children] so early." Fourteen thought the course would begin with 'chalk and talk' about the syllabus or principles of mathematics, and nine expected they would be told how to teach mathematics before working with children. "I expected to be trained in a lot of theory before we got near any children."

The interviewing task seemed to have a considerable impact on many of the student teachers.

Initial impact on 'teaching'

1. *Apprehension*

For some, the prospect of interviewing a young child, even with the guidance of an interview schedule, was scary; nine reported that initially they felt apprehensive and nervous, but for most there was a positive outcome. "At first I was rather anxious about teaching mathematics to children as I felt totally inexperienced, but I felt comfortable in the one-to-one [interview] situation." "It sort of felt like being thrown in the deep end at first but when we actually came down to doing it, it was a very enjoyable activity." For at least one student teacher, her apprehension about mathematics itself was dispelled by the interviewing experience.

I felt apprehensive as maths is not one of my stronger subjects, but after my time with Joshua I realise that maths can be fun, varied, and can relate to almost anything. This also helped me to change my opinion that maths is hard and boring.

For one mature student teacher (with a degree in mathematics), however, the first interview session was not enjoyable. "I felt nervous and unsure of myself. I need to relax, gain confidence, and not get so uptight." Another found it something of an ordeal too, "I was genuinely afraid of making a mistake and scaring the children."

2. *The challenge of listening to children*

Adopting a relaxed, listening approach, rather than dominating the conversation by questioning proved a challenge for five student teachers, "I found it quite hard to just listen to the children's ideas." A further five reported difficulty in thinking at their child's level to understand their responses. "It was challenging trying to think on the child's level, and trying to appreciate and remember that they have not had as much experience."

Nine frankly admitted that they found it a real challenge to remain neutral instead of telling their child s/he was right or wrong. "I found it frustrating trying not to say 'Yes, correct' or 'No, wrong'." A further 15 commented that they found it difficult to resist helping or correcting their child. For example, one wrote, "I learnt to listen to the

children's ideas while fighting the urge to put my ideas and answers into their mouths", another reported, "Trying not to put words into the child's mouth was probably the hardest thing", and a third remarked, "I wanted to tell the child when he had made a mistake. I **wanted** to teach, not just interview." Perhaps, as one student teacher commented, this stemmed from, "Wanting to always have something learnt by the end of the lesson."

3. *Probing and rephrasing proved sophisticated skills*

Thirteen mentioned that they realised it was important to probe further to get their child to explain answers, but this was much more difficult than they thought. "I was surprised at how difficult it was to discover the reasoning behind a child's answer" "[It is difficult] knowing how to develop on from their answers. Hindsight revealed a lot of missed opportunities. [The challenge is] to develop further questions that would have revealed how the children reached their conclusions."

Twenty-one student teachers recognised that they needed to rephrase some of the interview items so that their children understood better what was being asked, but to do this in a non-threatening manner proved quite a challenge. "[It was hard] trying to reword questions so the child could understand them." "Questioning has been a challenge to me, [especially] constructing easily understood questions which a young child can relate to."

Impact on views of how children learn

Although three student teachers felt that they didn't know what to expect about children's learning, five claimed that their views remained uninfluenced by the experience, and eight reported that their views had changed in ways which they could not specify, many were quite clear about how their ideas of children's learning had been influenced.

1. *Enjoyment promotes learning*

Fourteen student teachers commented that they now realised that when tasks are interesting and fun for the children then the children are likely to learn more. "I think that children learn better when it's fun; they are more involved." "Children take in more when the lesson is fun, the resources are interesting and they enjoy it." "It seems that learning is more rapid for a child who is well motivated and enthusiastic about what is being taught. All their interest is targeted at what is being learned."

2. *Experiential activities and discussion enhance learning*

Resources for the children to engage in 'practical' mathematics, and discussion about these mathematical experiences were recognised by 22 as assisting children's learning. As one student teacher wrote, "I feel that in the junior school mathematics is learnt through experiences, doing activities and talking about them." Another commented, "I certainly had my eyes opened. Concrete forms are very important; being able to 'see' the object is a major factor." A third reported, "They [children] love to be involved in

practical activities rather than a teacher-dominated 'listen and learn' situation." The value of resources other than texts had not occurred to some student teachers.

Up until now the thought of maths resources hadn't really crossed my mind but since I have done maths using my [interview] resource kit I have decided that from now on I will be making the best use of it, and frequent use of any resources I possibly can.

3. *Linking to children's prior understandings assists learning*

Twenty-five of the student teachers noted that when the tasks were related to things which the children had experienced then they seemed to have greater understanding of them. For instance, "[The children are] more interested in questions when they can relate to something that has happened to them, to experiences they have had." "My child enjoyed the pets' graph because she had many pets at home and could draw on her own experiences."

For some student teachers the idea that mathematics is part of life was quite a revelation: "The children made me realise that maths is everywhere, not something that is solely learnt in class." "I didn't realise that so much learning comes from life experiences; well, at that age it appears as if it does."

4. *Individual children's learning is unique*

Eighteen student teachers reported that it appeared that children can develop their own individual ideas and ways of thinking in mathematics, even at five years of age.

They learn it their own way, using skills they remember or have invented.

Young children have their own ideas and concepts which need to be expressed and developed. Children are capable of developing their own mathematical strategies.

Children don't systematically learn mathematics ideas. The child I was working with had difficulty with some things I considered basic, but could easily do other things I thought more advanced.

Sometimes children may take you by surprise by the way they think; they may not be right, or wrong for that matter, but have just thought about something in a totally different context to what you, as an adult, would think.

Impact on views about teaching in mathematics

Again a number of student teachers (8) considered that the interviewing experience had not affected their ideas about teaching. Nine felt that it had, but were not specific about how. For example, one wrote that she now realised there are "totally different ways to teach than what I

imagined." The majority, however, were clear about the impact it had had on their thinking about teaching. One recognised that teaching is not a simple process, "I've come to realise that teaching is a very complex occupation." In another case it apparently had a negative impact, "It's incredibly difficult. I don't want to do it!" The rest were more positive, if perhaps a little anxious in some cases, "I've got a long way to go [in developing my teaching]."

1. *Make learning enjoyable*

Twenty student teachers reported that they now believed that a teacher should ensure that the learning sessions for children are interesting and fun. They also realised that they would need to think a bit creatively to achieve this. "You need to be creative and think of interesting ways for the child to learn." "It has made me look for innovative ways to teach maths, especially as I disliked maths at school." "When a new topic is introduced a child should find it enjoyable and rewarding in order to want to achieve more. The teacher must make maths learning fun." "Maths should always be presented as fun and unthreatening so that they [children] can establish the confidence required to attempt work at higher levels."

2. *Make learning meaningful*

It was recognised by 15 that children should see purpose in the mathematical learning tasks and that these should be related to the real world of the children. "Children need to be able to relate maths to real life; there has to be a point to it." "You have to make a lesson personal by including children's own interests and relating it to their own everyday experiences." Six student teachers reported that using simple language at first would help the children make better sense of tasks and experiences. "I realised that simple language must be used in order for the child to understand."

3. *Adapt teaching to the needs of the children*

Almost one-third (33) of the student teachers commented that the interview had enabled them to assess their child's understanding of number. Fourteen were now convinced that it is important to identify the children's present understanding and build on that in teaching sessions. "Find out what they know and build on that." "It taught me to adapt my lesson preparation and materials to my student. Each student needs to be taken at his own pace." One way of building on such understanding, 15 student teachers now think, is to provide children with a variety of resources and hands-on experiences, together with discussion about these. "You need to use practical applications that are fun." "I always thought maths was pretty boring, but it can be quite exciting and stimulating if the correct resources are used."

4. *Provide the children with opportunities to explore and explain*

According to 13 student teachers, children should be provided with space to explore and think things out for themselves, and with challenges and guidance as needed. "I have now realised that children need to be listened to a great deal, rather than told." "Children need to be given a chance to explore, and given challenges to extend their knowledge."

"I had always been just 'taught' maths - or so I thought - but this idea of children doing most of the work, thinking things out for themselves, worked well."

Young children view things along their own lines and in their own terms (unless someone tells them otherwise) and being able to let them express what they think is a healthy practice as they learn not to be afraid to put their ideas forward.

I didn't realise the importance of not telling the child what the answer is straight away. I thought if a child didn't know an answer, you should tell them what it is straight away. There is much more emphasis on child enquiry and exploration, and working problems out amongst themselves. I think this is an excellent way for children to really understand concepts and ideas.

Five student teachers feel now that, as a teacher, it is important to try to appreciate from the children's perspective what it is like to learn. "To help a child learn, sometimes you have to think differently from the way you normally do. Try to see things in their perspective." "Think of the maths as you would be learning it for the first time; that is, put yourself in their shoes."

It has shown how you need to be able to adapt to the thinking and reasoning of young children. Expect the unexpected, and don't put words into the children's mouths. Let them explain what they think about it to you.

A further 6 commented that there is a need to provide a supportive classroom climate to encourage children in their learning. This requires teachers to adopt a 'relaxed' approach rather than playing a dominant part during mathematics sessions. As one student teacher noted, "Children seem to respond more if they are relaxed, and feel that they are able to answer questions, whether they be right or wrong." Another commented, "I found that they [children] don't reveal what they know without feeling comfortable in the situation."

5. *Exercise patience*

Nine student teachers commented that considerable patience is needed to be an effective teacher with young children in mathematics. "It requires a lot of patience on your side as you don't want to put words into the child's mouth but encourage them to try the problem."

The challenge to one teacher's views: A small case study

The results above are reported from a total group perspective. The impact of the interviewing experience on individual student teachers may be better appreciated by reference to the log-book notes of Lynda (not her real name). Lynda worked with a five-year-old boy called Felix and was surprised at both how much he knew and his willingness to make sense of the tasks.

Several factors appear to have assisted this change process:

1. The surprise element of interviewing a child early in the course seemed to disorient many of the student teachers with respect to their preconceived image of working with children.
2. The constraint of **not** teaching, but instead observing and talking with, the children forced a radical reconsideration of their role - something which teachers often do not come to until they have established management procedures in their classes and feel secure about the mathematics content.
3. The interview schedule items, together with the children's responses to them, required the student teachers to reconsider their ideas about how young children develop number concepts, and more generally how they learn in mathematics. That some came to think that mathematics learning could be fun and could be related to life experiences are telling points.

The data provide further insight into the process of professional change. Three factors that have been found to facilitate change are: (a) a changed philosophy and desire to change practice, (b) an experience of alternative ways of learning (with an alternative teaching approach being modelled) which opens up new teaching possibilities and a rethinking of philosophy, and (c) voluntary involvement in collaborative action research to investigate the effects of different teaching strategies, which can also lead to a rebuilding of philosophy. All take time.

In the present study, imposed constraints, together with a teacher-guide (the interview schedule) required a change of practice. This in turn led to philosophical change. Given the limited time allocated to us for preservice mathematics education (currently one course of 24 contact hours, and another of 50 contact hours), the student teacher professional development which resulted from the interview task seemed good value for time.

REFERENCES

- Crawford, K. Teaching in the manner they were taught. Paper presented to MERGA, Perth, July 1991.
- Klein, M. An investigation of constructivism and pre-service teacher education through action research. Paper presented to MERGA, Perth, July 1991.
- Nisbet, S. (1991). A new instrument to measure preservice primary teachers' attitudes to teaching mathematics. *Mathematics Education Research Journal*, 3 (2), pp. 34-56.

If he didn't quite understand what we were doing he'd still do it and follow my instruction but be much happier once he'd figured out what it was all about.

If he couldn't do something, for example, count in 2's, he'd try and work it out, and most of the time did. He would then try to explain to me what he'd done, although he didn't have the right language to do this.

Lynda came to realise that simply-worded instructions are needed for young children, and that encouragement to try seemingly difficult tasks is required.

If you can get a child to try something, instead of just saying they can't, then they will usually benefit from it, and learn more than if you just told them. They will also be on the way to taking responsibility for their own learning. A child should always feel confident to try something and not be afraid that they're going to be wrong or laughed at.

Lynda decided that enjoyment and life experiences play an important role in learning mathematics.

To learn something children definitely have to enjoy it. They seem to learn an amazing amount by themselves through their everyday activities.

Finally, Lynda decided that there is more to mathematics and mathematics teaching than she had imagined.

I have come to understand that maths is a much broader subject than I had thought it was. Real maths is everyday stuff. I think it has to be, otherwise there is no point to it.

Beforehand I thought you would just have everyone in the class group doing the same, but now I see that just about every child needs to be working on their own activity, and it must be hard work for the teacher.

DISCUSSION AND CONCLUSION

The data reveal that as a group the student teachers changed many of their views about learning, teaching and mathematics as a result of the two-part interviewing experience. Their comments suggest that many found it quite a struggle to 'shake off' traditional ideas which had become firmly embedded in their belief systems. In some cases, perhaps many, these included the notion that there is a right way of working with children in mathematics - as indicated by concerns about making mistakes with the children.