

Teaching your first mathematics class: Were you ready?

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Much of the debate surrounding the publication of the results of the Third International Mathematics and Science Study (1997) focused on the role of the teacher, and almost inevitably included discussion of the standards and issues of pre-service teacher education. The part teachers' beliefs play in their development as competent, confident teachers of mathematics has been addressed by several commentators, and this, together with an emphasis on the importance of reflection in teaching has influenced the development of pre-service programmes. This study evaluates an optional course in mathematics education that aims to prepare teachers for the classroom by focusing on their beliefs. Twenty-five beginning teachers describe the extent to which completing the course influenced their initial teaching, the constraints they experienced in putting their philosophies into practice and their ideas about how the course and their pre-service education mathematics programme could be enhanced.

Introduction

Students enrolled in the Bachelor of Education (Teaching) (BEd [Tchg]) at the Auckland College of Education (now the Faculty of Education, The University of Auckland) completed a series of compulsory courses during their three-year programme. These included three mathematics courses designed to enable them to develop the necessary skills and knowledge to teach any class from year 1 to year 8 in New Zealand schools. Courses in education and professional inquiry, and teaching practices in schools, complemented the curriculum studies. During their final year, students selected three optional courses for further study. These courses, which were offered for the first time in 1999, included one developed by the Centre for Mathematics Education entitled *Mathematics Education: Getting ready for the classroom*.

All the students who chose to enrol in this course had completed the three compulsory mathematics courses. In these they had been working with individual children and small groups, diagnosing mathematical strengths and needs and developing appropriate lessons, and all had had some experience of teaching mathematics during their teaching

experience placements. This additional optional course aimed to help them to build on this prior experience and knowledge in order to become more competent and confident in planning, implementing and evaluating effective mathematics programmes for their classes, within the school and wider community setting.

Background

The effectiveness of teacher education programmes in preparing teachers for teaching mathematics has long been the subject of debate. Few pre-service institutions claim outstanding success in producing teachers with the knowledge and skills that will enable them to fulfill the role of the mathematics teacher as defined by the National Council of Teachers of Mathematics (1991) in:

creating a classroom environment to support teaching and learning mathematics, setting goals and selecting or creating mathematical tasks to help students achieve these goals, stimulating and managing classroom discourse so that students and teachers are clearer about what is being learned and analysing student learning, the mathematical tasks, and the environment, in order to make ongoing instructional decisions (p. 4).

In New Zealand, the publication of the Garden results of the Third International Mathematics and Sciences study (TIMSS) (Garden, 1997), the Review of Teacher Education green paper (Ministry of Education [MoE], 1997), and the report of the Science and Mathematics Taskforce (MoE, 1997b) have all suggested that major inadequacies still exist in the teaching of mathematics in New Zealand schools. Garden (1997) in his report on New Zealand children's TIMSS results, contends that inadequate pre-service teacher education means that "many teachers begin their careers ill equipped to provide students at any level with effective programmes in mathematics and science" (p. 250). He links this inadequacy to what he considers to be low entry standards and minimum requirements in pre-service courses.

While Colleges of Education constantly worked to address such issues, many of those involved (Thomas, 1998; Begg, 1997; Wilson & Ball, 1996) believed that the pre service teachers were themselves part of a deeper problem, in that many had been subjected to unsatisfactory mathematical practices as students and consequently had little liking for,

or record of success in the subject. Indeed, “in the face of prospective teachers’ vivid and compelling histories as students, teacher intervention has typically been a weak intervention” (Wilson & Ball, 1996, p. 124). Indeed, the lack of mathematical success of many students entering pre-service programmes is a concern but it can result in a determination on the part of some students to teach more effectively than they were taught. This is not, however, simply a matter of improving technique; rather a whole new approach is required.

For many years, school programmes in mathematics have been based on the principles of behaviourism, where material is presented to students in a linear fashion (that is, step by step) and correct responses are rewarded. Behaviourist techniques tend to focus on outputs rather than understandings (Young-Loveridge, 1994, p. 307). While some elements of this approach may still be useful in the achievement of low order skills, the current curriculum, and all mathematics education courses undertaken by the students, are based on teaching approaches more aligned with the theory of constructivism, where “learners actively construct their own understandings rather than passively absorb or copy the understandings of others” (Simon & Shifter, 1991, p. 310). Such approaches require a radical change in the role of the teacher, who no longer tries to transfer his or her knowledge of mathematical concepts directly to the learner, but instead strives “to maximise opportunities for students to construct concepts, and to give fewer explanations and expect less memorisation and imitation” (p. 325).

Although most student teachers believe that the constructivist approach has much to recommend it, they are to some extent disadvantaged by their own prior experience as learners of mathematics. In the twelve or thirteen years that most spend as school students they develop beliefs and attitudes which will eventually have an influence on their own teaching. “During this apprenticeship of observation, teaching models are internalised, and the student learns to ‘take the role’ of the teacher” (Lortie, 1975, p. 61). However, because most pre-service teachers were not taught by constructivist approaches, these internalised models are no longer applicable to the teaching role and may need to be “unlearned”. Furthermore, the need for practical experience of

constructivist teaching approaches in mathematics may not be met during their pre-service experiences in schools, and constructivist approaches may not be used in the schools to which they are appointed as beginning teachers.

The curriculum reforms have resulted in renewed international debate about the importance of the personal mathematics knowledge of student teachers. Recent official reports from New Zealand (Ministry of Education, 1997) and the United States (National Commission on Mathematics and Science Teaching, 2000) insist that teachers require an improved level of academic study to develop the content knowledge necessary to implement the curriculum. While some researchers suggest that the content knowledge gained from academic study and content knowledge necessary for teaching may not be the same, the need for a stronger knowledge base is generally acknowledged (Brophy, 1991; Brown & Borko, 1992). Indeed, “Without adequate content knowledge, student teachers spend much of their limited planning time learning content, rather than planning how to present the content to facilitate their students’ understanding” (Brown & Borko, 1992, p. 218).

Research in the United States (Raymond, 1997; Thompson, 1992) has examined the role teachers’ beliefs play in establishing and maintaining high quality mathematics programmes for the children they teach. This research suggests that pre-service teacher education is more effective in promoting high quality mathematics teaching when it deals with classroom practice through helping students to examine, and perhaps amend, their beliefs about teaching and learning mathematics, rather than when it simply deals directly with classroom practice.

This focus on beliefs about learning, together with the emphasis placed on the development of reflective practice in the overall BEd (Tchg) strongly influenced the design of the stage three course *Mathematics Education: Getting ready for the classroom*. Courses at the “Q7” (stage three in university language) level of the New Zealand Qualifications Authority guidelines were expected to provide opportunities for synthesis of the theory and application of curriculum. In this particular course this was

achieved by focusing on a range of aspects considered to be crucial to a successful mathematics teaching programme and requiring participants to align each of these with their personal philosophies about teaching mathematics.

Initial work in the course focused on helping students to develop these personal philosophies. Further topics included the critiquing of written resources, the process of developing a school policy, programme planning, and partnership with parents. Students' work in each of these areas was assessed, with a major portion of the marks assigned to the manner in which the work linked to the individual's philosophy. In the final component of the course students were required to identify possible obstacles to the implementation of a mathematics programme based on their philosophy, and discuss ways in which they could overcome these.

The study

The objective of the study was to ascertain the effectiveness of the course in preparing participants for their role as beginning teachers of mathematics. It focused on the retrospective viewpoints of the participants after their first term of employment, and the research questions, which guided the study, were:

- To what extent did completing the course influence the initial teaching practices of the successful participants? What were the constraints?
- Which topics were of particular value? Which were of limited/no value?
- What suggestions did the participants have for improving the effectiveness of the course?

Methodology

The investigation took the form of a programme evaluation, which Kemmis (1986) defines as “the process of marshalling information and arguments, which enable interested individuals and groups to participate in the critical debate about a specific programme” (p. 118). It is important to note, however, that the study investigated only one aspect of the programme (its perceived initial usefulness according to participants),

and to acknowledge that a full programme evaluation would also include the informal evaluations that occur as a natural part of the development and implementation of that programme. Kemmis sees it as critical that the formal process should not ignore or supplant these informal ones, but rather focus and sharpen them.

In evaluative studies, a distinction between formative and summative evaluation can be made on the basis of the functions of each: “In its formative function evaluation is used for the improvement and development of an ongoing activity (or program, person, product etc.). In its summative function evaluation is used for accountability, certification, or selection” (Nero, 1986, p. 17). While the study can be described as summative in that it was carried out after the course (and the participants’ first term of teaching) had been completed, its function met Nero’s definition of formative evaluation in that there was a strong intention for the results to be used to improve the course for the benefit of future participants.

Method

Participants were drawn from all students who had completed the course successfully, and who had been employed as classroom teachers of Year 1-8 children in the first term of the year 2000. Twenty-five of the beginning teachers completed the questionnaire and of these, seven who were available participated in interviews with the researcher. The interviews were tape-recorded and transcribed for analysis.

Instruments

Questionnaires and semi-structured interviews were used to obtain data relating to the research questions. The questionnaire consisted of three sections. In the first of these, participants were asked why they chose to include the course in their course of study. The purpose of this was to check the extent to which the aims of the course and the expectations of the students coincided. In the second section, information relating to the class level taught, and the decile rating (an indicator of the socio-economic status) of the school in which participants were employed as beginning teachers was sought, as it was felt that these could be discriminating factors. The third section focused on the course

content. Participants were asked to indicate the overall extent to which they felt completing the course had influenced their first term of teaching, and then to rate each of the major topics to establish its perceived usefulness and comment on the reasons for their ratings. Finally they were asked to identify aspects that they felt should have been included, and any further suggestions they had for improving the effectiveness of the course in the future.

The interviews were semi-structured, with participants being asked to clarify and elaborate upon their answers to the sections of the questionnaire that dealt with specific components of the course and suggestions for additions and improvements. They were also invited to explore ideas raised by others and share any other relevant information they chose.

Analysis

The completed questionnaires were examined and sorted according to the decile rating of the respondents' schools, and within that classification, according to class level. This organisation enabled the aspects of decile ratings and class levels to be considered as the responses were analysed. Responses to each question were recorded and studied to identify key features and emerging themes. The data were then systematically re-examined and codified, and then counted to obtain evidence of frequency. Data from transcripts of the interviews were analysed using the same identified key features.

Findings

All twenty-five teachers who responded to the questionnaire provided information regarding the class level at which they taught, and twenty-four stated the decile rating of their school. This information showed that the respondents held teaching positions across the full range of decile ratings and primary school class levels. These aspects did not provide any discernable difference in responses.

Reasons for taking the course

Twenty respondents reported that they selected the course because of their perceived ability in, and attitude towards, mathematics. Nine of these enjoyed mathematics and were aware of its importance, while eleven felt mathematics was a personal weakness and lacked confidence in the subject. Of those who felt positive about their own mathematics, four wanted a practical paper to prepare them for the classroom, four expressed a need to increase their skills and knowledge of mathematics teaching, and one liked the timetable slot. Of those who felt that mathematics was not a personal strength, five wanted a practical paper and six wanted to increase their skills and knowledge. Of the five respondents who did not comment on their personal attitude and ability three wanted a practical paper, one “wanted to be ready for the challenge [of teaching]” (Teacher, year 7 class, decile 1 school) and one “needed a maths paper” (Teacher, year 1-2 class, decile 9 school). It is interesting to note the similarity between the expectations of the groups: personal attitude and perceived ability in mathematics did not influence what participants hoped to gain by enrolling in the paper.

Influence of the course on initial teaching

Twenty-three of the respondents felt that completing the course had influenced their initial teaching, at least to some extent. Four felt that their initial teaching was greatly influenced and these four had selected it because they lacked confidence in teaching mathematics. These teachers noted their increased confidence and ability to reflect upon their practice and mentioned specific skills that they had gained from the course and were now practicing in their classrooms.

I use many of the games and activities that I learned; I have used the maths newsletter idea; I have reflected back on my philosophy often.

(Teacher, year 5/6 class, decile 4 school)

Nineteen of the respondents felt completing the course influenced their initial teaching “to some extent or moderately”. Their comments also included references to the value of both philosophical and practical aspects of the course.

It made me look at my philosophy about maths, what I wanted my children and myself to achieve.

(Teacher, year 5 class, decile 10 school)

I have included problem solving sections into my programme and have injected more “fun” into maths. There is a strong emphasis on using concrete materials to secure and reinforce concepts.

(Teacher, year 4 class, decile 7 school)

The two respondents who felt that completing the course had not influenced their initial mathematics teaching at all were among those who had seen mathematics as an area of personal strength when selecting the course. One reported that she was “not conscious of any benefit” and the other reported that all planning and timetabling had been done for the class before her arrival at the school.

Most respondents identified constraints that they felt prevented them from fully implementing learning from the course. In five cases these related to their desire to fit in to the school setting.

I started my job in week 4 so I was mainly concerned with familiarising myself with how the school “worked”... Towards the end of term I was able to concentrate on how “I” wanted to run my maths programme.

(Teacher, year 1/2 class, decile 1 school)

As a beginning teacher I felt like I should observe what was running in the school at first and then incorporate my own ideas, beliefs and philosophy into my classroom programme.

(Teacher, year 2 class, decile 1 school)

Three respondents reported that they felt unable to fully utilise their learning from the course because they were uncomfortable with the class level to which they had been assigned, two felt handicapped by a lack of resources in the school, and four cited the constraints of having a large number of children and/or a wide range of abilities within the class, insufficient time, and personal inability to manage the task.

The first term is so overwhelming that I felt I could only focus on one programme at a time, so I got my reading groups up and running first.

(Teacher, year 2 class, decile of school unknown)

Value of specific components

The data in Table 1 summarises the participants' views of the extent to which five of the major topics (described earlier) covered in the course proved useful in their first term of teaching.

Table 1: Perceived usefulness of major topics

| | Resource critique | School policy study | Programme planning | Partnership with parents | Alignment of philosophy with practice |
|--------------------|-------------------|---------------------|--------------------|--------------------------|---------------------------------------|
| Very useful | 10 | 2 | 16 | 11 | 15 |
| Of some use | 11 | 10 | 8 | 10 | 8 |
| Not useful | 4 | 13 | 1 | 4 | 2 |

The topics of programme planning and aligning their philosophy with intended practice were considered “very useful” by most participants. These appeared to be the aspects that most closely related to their immediate situation. Twelve respondents indicated the probability that their ratings would change as their experience increased. This was particularly evident in the area of school policy development.

I think it will be useful. I think that I've shied away a bit at the moment because I haven't felt really confident in my programme anyway but I'm finding out that with the knowledge I have from college that I should really be helping them out or be on the team. I have a fair bit of knowledge on policy from that and how to set it up so I'm probably a really good candidate for doing it.

(Teacher, year 1 class, decile 10 school)

It hasn't been yet ... but I can see that it will be because we went through how they're made and what you do and stuff like that but at the moment I'm just an observer of the curriculum areas, just sit back and watch.

(Teacher, year 2-3 class, decile 8 school)

This was also the case with both respondents who stated that they found the final topic “not useful”. One commented:

Although I enjoyed writing my philosophy and relating it to intended practice, it has been put “on hold” momentarily while I come to grips with the reality of teaching maths to 31 children with a vast range of abilities, interests and needs.
(Teacher, year 4 class, decile 7 school)

However, three of those who found the final topic “very useful” commented on its immediate applicability to their situation:

Articulating my philosophy of teaching maths has been extremely helpful for confidently answering questions at interviews and reporting to parents.
(Teacher, year 5/6 class, decile 6 school)

Three responses suggested that the topic “Partnership with Parents” may have had generic rather than specific mathematical benefits:

I would send regular letters home asking for this and that, not just to do with maths actually, but I quite like having done the maths letter because in a way it sort of relieves me to feel oh its okay to send letters home.
(Teacher, year 7 class, decile 7 school)

Suggested additions and improvements

The final section of the questionnaire asked respondents to specify topics that they felt should be added to the course, and any further suggestions they had for improving the course in the future. The most common responses to the question of additional content were concerned with resources, content knowledge and classroom management. Twenty-three respondents felt that a greater focus on examining and developing resources was needed. Eleven suggested building “resource banks” from available material, five wanted to design and make their own resources, and seven wanted more help in using specific resources commonly found in schools.

Sixteen responses related to mathematical content. Five teachers felt that a closer examination of the curriculum, including identifying essential learning and defining minimum standards would be helpful. Eleven responses suggested developing units of work and strategies for teaching specific skills.

Basic ‘nuts and bolts’ techniques of how to effectively teach essential concepts.
(Teacher, year 2 class, decile 8 school)

Fourteen responses related to issues of classroom management. Ten of these were concerned with ways of grouping children, (including the use of existing records), and managing the groups once they were established. The remaining four suggestions related to dealing with a range of abilities, specifically strategies for planning for and working with children with special needs and those with special abilities.

Single responses suggested including the topics of linking mathematics to other curriculum areas and planning for mathematics outside the classroom. Five responses requested coverage of topics that are already present in the course; it is unclear whether this was because respondents felt these needed to be covered in more depth or whether they were absent for the class concerned.

Twelve respondents made a range of suggestions relating to improving the effectiveness of the course. Three suggested visits from a beginning teacher and/or watching an experienced teacher taking a mathematics class would be helpful in providing a basis for the discussion of issues such as the length of time it takes to establish routines, how a range of abilities can be catered for, and how to identify and utilize the help that is available. Four respondents wanted “more hands-on, less theory” and two suggested advising course participants that learning to teach well was a long, slow process! Three respondents felt that continued access to lecturers at the college would be helpful.

An 0800 helpline would be great!
(Teacher, year 2/3 class, decile 8 school)

I think it should have been set up that, rather than us going to an education centre, which we do for our BT courses, that we were here back with the people that took us for three years, that nurtured in some of us a love of [mathematics]. We now have something to “hang” on what you were telling us.

(Teacher, year 4 class, decile 7 school)

Discussion

Pre-service teacher education programmes such as the BEd (Tchg) aim to provide graduates with the knowledge and skills that will enable them to begin their teaching careers successfully. The course undertaken by the students reported in this project aimed to better prepare them for this initial teaching in mathematics through a focus on their personal philosophy of mathematics teaching. Results from the survey indicate that most of the students who participated felt that the course influenced their initial teaching to at least some extent, and that four of the five major topics within the course were of use. The positive response to the component of the course requiring participants to relate their philosophy to practice seems to confirm the value of the focus on developing and strengthening participants' personal philosophies about teaching mathematics that formed the basis of the course.

In her model showing how mathematics beliefs (the nature of mathematics, learning mathematics, teaching mathematics) influence teaching practices, Raymond (1997) includes two additional categories of influence. These relate to the immediate teaching situation, (the students, the mathematics topic at hand, time constraints) and social teaching norms (the school setting, the curriculum, colleagues, parents of students). It would seem that many of the difficulties experienced by the beginning teachers surveyed relate to issues in these two categories, and that more emphasis placed on these aspects may help to make the course more immediately effective.

One aspect that the beginning teachers surveyed believe was not covered adequately is that of subject matter – Raymond's "mathematics topic at hand". The final questions in the survey brought an almost unanimous response – the teachers felt a real need for assistance in selecting and developing resources relevant to the children they teach, and specific units of work in key areas of mathematics which they can adapt to suit individuals or groups.

Several of those interviewed referred to the abundance of material “out there”, indicating that the problem with resources is probably one of selection rather than availability of suitable material:

We’ve got a lot of stuff in the resource room but it’s a very small room and it’s hard to find that as it’s all squashed in and sometimes I go in there and I just end up walking out because it’s all too much.

(Teacher, year 6/7, decile 6 school)

Given the positive response to the question relating to the usefulness of that part of the course, it would seem that beginning teachers have the ability, but lack the time required for such selection.

The same cannot be said for the issues of content. Most of those surveyed felt the need for more specific knowledge of how basic mathematical ideas can be developed and suggested that identifying the most important areas of focus at each level would be helpful.

I’m never exactly sure what it is I’m supposed to be covering so I just try and cover everything!

(Teacher, year 6/7, decile 6 school)

Although the survey did not include questions relating to the mathematics subject knowledge of participants, almost half of those who selected the course did so because they believed that mathematics was a personal weakness. More specific research may show a relationship between this and the expressed need for more content knowledge.

The responses related to classroom management were concerned with the more generic issues of meeting children’s individual needs. While it could be assumed that principles relating to this would be introduced to students in compulsory Professional Inquiry courses, it seems that the application of these to mathematics teaching and learning may need to be specifically included in the course.

The strong influence of the school environment was evident in all responses. Brown and Borko (1992) reviewed several functionalist studies that indicated that there was a

tendency for beginning teachers to develop attitudes and behaviours that are dominant in the existing culture of the schools.

Such findings are troublesome to people who hope to see mathematics instruction reformed, for they suggest that novice teachers will most likely not implement innovations in either curriculum or teaching practice unless those innovations are also part of the culture of the schools where they learned and where they teach and learned to teach (p. 223).

Despite finding it “very useful” to describe how they would put their philosophy into practice and identifying strategies to deal with constraints, most beginning teachers felt a strong need to conform to the culture of the school. In the case of New Zealand teachers, this is probably linked to practical concerns relating to their career prospects. Beginning teachers are very aware of the influence that can be exerted by their more experienced colleagues, as one respondent noted.

As a beginning teacher my philosophical beliefs are viewed with scepticism by more experienced teachers, and these are the ones who tick the boxes for my appraisal and beginning teacher reports.

(Teacher, year 7/8 class, decile 7 school)

Recent reports relating to the effectiveness of pre-service teacher education (Grudnoff & Tuck, 2000; Thomas, 1998) stress the need for collaboration between schools and the providers of pre-service teacher education in dealing with the ongoing professional development and adjustment of beginning teachers. The suggestions of bringing beginning teachers in to discuss issues with students participating in the course, and having beginning teachers come back to the college for some of their in-service development time would seem to go some way towards developing such collaboration.

Conclusion and implications for practice

This study sought to evaluate the effectiveness of the course *Mathematics Education: Getting ready for the classroom* in preparing student teachers for their role as beginning teachers of mathematics. The results indicate that the participants believe that more emphasis needs to be given to the issues of specific teaching content, identification of key resources, and classroom management of the mathematics programme. In considering how these needs can best be addressed, it is important to consider the

position of the course within the BEd (Tchg) qualification and the range of courses offered through the Centre for Mathematics Education. Ongoing discussion of the issues will be needed to ensure that changes can be made to the course without compromising the aims and purposes of the total programme.

On a wider front, the idea of beginning teachers returning to the teacher education institution for some of their continuing professional development could be further investigated. Opportunity to share project work and resource development would provide a rich source of learning and discussion for both beginning teachers and teaching education staff. However, while actions such as these may better prepare beginning teachers to teach mathematics, it is acknowledged that they will not provide a perfect solution.

Nothing can really prepare you for the realization that you are responsible for the learners in your care. It's a bit like having a baby – until you experience it you can't know!

(Teacher, year7/8 class, decile 7 school)

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