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Author(s)	Lim Suat Khoh and Yap Sook Fwe
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Mathematics Teachers' Perceptions of their Preparedness for Teaching

Lim Suat Khoh & Yap Sook Fwe

National Institute of Education, Nanyang Technological University
Singapore

Introduction

Secondary Mathematics teachers in Singapore are normally certified for teaching by undergoing a Postgraduate Diploma in Education (PGDE(Sec)) at the National Institute of Education (NIE) which is the sole teacher training institution in Singapore. However, as graduates who have read at least some mathematics at university level, their teacher education goes beyond the one academic year professional training course as their mathematics knowledge is acquired through their own university and preceding mathematics education. Such PGDE(Sec) students are usually graduates from the National University of Singapore (before 1995, the NUS is the only university in Singapore producing arts and science graduates) and from universities in the United Kingdom, the USA, Australia and New Zealand.

As teacher educators preparing pre-service teachers for teaching Mathematics at Secondary level, the authors were concerned with the effectiveness of mathematics methodology courses at the NIE in preparing the PGDE(Sec) students for teaching. We were also concerned with the students' prior competency in their subject area of mathematics which would affect their effectiveness as teachers. In Leitzel et al [1991], recommendations for the mathematical preparation of teachers of mathematics called for the enabling of mathematics teachers to (i) learn mathematical ideas, (ii) connect mathematical ideas (iii) communicating mathematical ideas, (iv) build mathematical models and (v) use technology. The achievement of objectives (i), (ii) and (iv) can hardly be achieved through the short one-year professional course which must necessarily build on the trainee teachers' previously acquired mathematical knowledge, views of mathematics, habits of mathematical thinking, etc.

With the exception of the stricter requirements for mathematics at Junior Colleges (for 'A' level students aged 16 to 18) which is generally taught by Honours graduates in Mathematics, there seems to be a basic assumption that as PGDE(Sec) trainee teachers are graduates with at least some undergraduate mathematics, their mathematical knowledge should be sufficient for teaching at secondary levels.

In this context, two problems faced by the mathematics educators who were training these students are discussed here. Firstly, many of these graduates had the perspective that mathematics was a procedural subject and thus tended to view mathematics as a rather inflexible set

of rules. During the pre-service methodology course, the lecturers tried to expose the trainees to a different perspective of what mathematics was with special emphasis on teaching for conceptual understanding. Trainee teachers were also encouraged to use activity-based and motivating approaches which were aimed at meaningful learning by students. However, as observed by Jones [1995], there was tension between teaching for understanding of concepts and teaching how to use a variety of procedures and rules and in our observation of mathematics teaching, the two aspects are seen by teachers to be competing rather than complementary to each other. It was also observed that although the trainees seemed to be initially "converted" to such methods of teaching, many soon reverted to teaching for procedural knowledge and branding the former methods as impractical,

giving reasons that ranged from lack of time, syllabus constraints and examination pressures to lack of resources or the inability of their particular "weak" students to learn concepts.

Secondly, Jones [1995] also pointed out that "teachers with deeper understanding of mathematics tend to tailor their teaching to more conceptual views and that teachers with a lesser knowledge of mathematics tend to use a more rote structure", an observation which is also true in our experience of supervision of trainee teachers in Singapore. This observation is certainly not intended to place harsh judgment on the teachers. In fact, it may be the lesser of two evils as correct rote learning of rules is preferable to the little or wrong understanding of concepts resulting from unsuccessful attempts to achieve meaningful learning. Although some trainees gamely tried out the newly learnt approaches, correct meaningful learning of concepts did not take place because the trainees' own understanding of the mathematical concepts was not sufficiently well-grounded for the more flexible learning style which required skillful guidance by the teacher to achieve its objectives.

The mathematics methodology course of the PGDE(Sec) had been evolving through the eighties to focus on more applied aspects of teaching various topics rather than mainly emphasising on theories of learning and expecting the trainees to apply such theories in the school situation. In an effort to encourage more self-learning and higher understanding by the trainees, the course was re-structured in 1993 for the 93/94 academic year and a description of this is given in Lim & Yap [1996]. Although course evaluations at the end of each academic year were positive since the late eighties, there was no data on how effective the training was after the trainees had graduated from the institution. It was felt that such research findings would be extremely useful in course review and contribute to better preparation of mathematics teachers.

The research study, which began in December 1994, thus set out to

examine secondary mathematics teachers' perceptions of their preparedness for mathematics teaching in the areas of (a) their content knowledge, (b) their professional pre-service training and (c) needs for further professional development in the area of mathematics. This paper reports the part of the findings of the survey which relates to the quantifiable responses.

Instrumentation and sample

A survey form consisting of 3 sections was used to gather the data. In Sections A and B, there were 4 statements and 7 statements respectively where the respondents had to rate their agreement or otherwise on a 5 point scale as well as 1 additional open-ended question for their inputs in each section. Section A of the form dealt with mathematics studied at the university level and the extent to which university level mathematics was useful and relevant to the respondents as mathematics teachers. Section B sought the respondents' views on the pre-service training during their PGDE(Sec) Programme with special emphasis on the mathematics methodology course. Section C consisted of 4 open-ended questions which sought the respondents' feedback on their training.

The sample consisted of all graduates of the PGDE(Sec) Programme who underwent the Mathematics Methodology course in the cohorts of the 92/93 and 93/94 academic years. The reasons for choosing these cohorts were as follows:

(1) Undergraduate and professional courses would be fresher in the minds

of those who graduated rather recently.

(2) As the study was carried out in mid-1995, these teachers would have had some one to two years of teaching experience after their training and would be able to assess the relevance of their courses in the light of such experience.

The number of survey forms sent out and the number returned are given in Table 1 below.

Table 1: Response Rate

Cohort	No. sent out	No. returned	% Return
92/93	132	27	20.5%
93/94	303	71	23.4%

Findings

The results of the survey discussed in this paper will be restricted to those questions where the respondents rated their agreement with the

statements provided. For Section A on mathematics studied at University level, there were 4 statements and Table 2 below gives the statements and the percentage of the respondents in each of the categories Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree. The total number of forms returned was 98 and the total number of responses for each statement was 95.

Table 2: Percentages of Responses in the 5 categories for the Statements on University Mathematics

Statement	SD	D	N	A	SA
A1 University Math provides me with a better understanding of the Math concepts which I teach.	4.2	27.4	22.1	33.7	12.6
A2 Univ Math enables me to understand more clearly what Math is all about.	3.2	12.6	24.2	43.2	16.8
A3 The Math I studied at university inspired me to love the subject.	9.5	26.3	26.3	24.2	13.7
A4 I feel inadequate in some areas of Math at the secondary level.	21.1	29.5	19.0	26.3	4.2

For Section B on the professional pre-service training, there were 7 statements, B1 to B7 and Table 3 shows the agreement with these statements in percentages of total number of responses. The total number of responses for each statement ranged from 96 to 98.

Table 3: Percentages of Responses in the 5 categories for statements on professional pre-service training

Statement	SD	D	N	A	SA
B1 I feel that the methodology course was useful to a beginning teacher.	2.0	5.1	11.2	64.3	17.4
B2 Pre-service training should include content mathematics as well as methodology course.	3.1	12.4	14.4	45.4	24.7
B3 I was able to apply general education courses (not math meth courses) to the teaching of mathematics.	6.3	7.3	13.5	63.5	9.4
B4 The methodology course has prepared me well to teach mathematics.	3.1	9.2	32.7	46.9	8.2
B5 I feel inadequate in choosing effective approaches to teach mathematics during my teaching experience.	4.1	29.6	30.6	33.7	2.0
B6 The methodology course provided insight into the meaning of mathematics.	5.1	14.3	20.4	51.0	9.2
B7 I feel that the methods/approaches learnt in the methodology course are not practical in the real school situation.	5.2	28.1	28.1	13.0	28.3

Implications of the Findings

As the Mathematics Teachers' content knowledge and attitude towards Mathematics were mainly established before their pedagogical training, the findings from Section A throw some light on the entry attributes of the pre-service teachers. From responses to A1 and A2, it can be seen that University Mathematics provided 46% of them with a better understanding of the mathematical concepts which they now teach while enabling 60% of them to understand the discipline itself better. As the content Mathematics studied at the University was supposed to provide grounding in the discipline, it is worrying that less than half of these Mathematics teachers find their University Mathematics education helpful in the concepts they now had to teach. However, it must be noted that the University Mathematics courses have different objectives from Teacher Education: University courses are meant to produce Mathematicians and not Mathematics teachers and it may be inferred from the 70% high agreement with B2 that the teachers felt a need for better grounding in the concepts related to the school curriculum. In actual fact, experience has shown the teacher educators that our graduate teachers need such grounding and within the time constraints, the methodology courses at the Institution do incorporate the discussion of the more difficult concepts but embedded in the teaching of the various topics rather than in separate content modules.

The responses to statement A3 showed that only 38% were inspired by higher level Mathematics to love the subject. Although Mathematics has always been a subject which inspires awe but not love, as evidenced from literature on attitude towards Mathematics, the sample is not from the general public but consists of teachers who have chosen to read Mathematics at tertiary level and have chosen to be Mathematics teachers. As one of the important attributes of an effective teacher is his/her enthusiasm for the subject, it appears that the one-year pre-service training would have to try to inculcate such enthusiasm in the remaining 62%.

As for the teachers' content preparedness, the responses to A4 showed that 30% agreed or strongly agreed with the statement of inadequacy. The written responses showed that the teachers felt inadequate in only a few topics and the topics which occurred more often in the responses were the more conceptually difficult topics such as probability, statistics, vectors and mechanics. From some responses, it was clear that some of the teachers had not done these topics in their own mathematics education. Although the statement referred to secondary mathematics, some respondents noted inadequacy in areas covered in 'A' level Mathematics such as calculus and trigonometry. Two also noted the area of problem-solving which is the emphasis of the new syllabus. Perhaps this is not related to University Mathematics but to the teachers' concern with their own ability to solve non-routine and

unfamiliar problems as they have been used to a more procedural and algorithmic approach.

The findings showed that a great majority found the course useful (B1) and were able to apply the general education courses to their teaching

(B3). However, although only 12% felt that the methodology course had not prepared them well to teach, 33% were neutral to that statement, leaving 55% who thought that the methodology course prepared them well for teaching. This may be tied in with the responses to B7, where the responses were about a third disagreeing, 40% agreeing and the rest neutral to the statement regarding the impracticality of the methods advocated. It may be inferred that the teachers found that some aspects of the methodology course impractical in the school situation and they were not well-prepared for the realities of the heavy curriculum and examination-driven culture. Furthermore, from experience, it appears to be the misconception of teachers and even some school administrators in the local system that the pre-service course would cover almost all of their necessary professional competence rather than provide the foundational level of teacher education in mathematics which would be further developed through experience and in-service courses.

Furthermore, the respondents who felt the methods were impractical were asked to elaborate and from the 40 responses, 25 mentioned "time constraints" or lack of time for preparation i.e. within the tight syllabus constraint, it took too long to teach for relational understanding and meaningful learning as opposed to teaching for procedural knowledge. Quite a few also mentioned that the methods were unsuitable for weaker students, implying that only better students could see the connections and meanings. Such returns show that the mathematics educationists have to work harder to make clear to the teachers that it is precisely the weaker students who need to see meaning in the mathematics they are learning. As for the packed syllabi, it is hoped that with the changing emphasis on thinking and problem solving, the curriculum can be modified to trim down on quantity to provide time for meaningful learning and for higher order skills such as analysis, synthesis and applications.

In choosing effective strategies and approaches (B5), the responses were roughly divided equally among those who agreed, those who disagreed and those who were neutral. The last question of Section B, B8, was open-ended, requesting respondents to suggest in-service methodology courses which may be relevant or useful to them. The responses to this question also provided evidence that beginning teachers sought more training in certain areas of their teaching and these included effective teaching strategies in an assorted list of topics, especially higher level topics, and methods for teaching weaker and unmotivated students.

Conclusion

Course evaluation has been always been carried out at the end of the PGDE(Sec) Mathematics Methodology course year after year and the results of recent years have usually been very positive in that the trainee teachers found the course useful. The results of the present study show that there is much more to be done, either in meeting the needs of the teachers or in sharing better with them the philosophy of mathematics education which seems to be at odds with the demands of the system.

In the 1993 revision of the methodology course, a conscious effort was made in the restructuring to include in each topic a serious discussion of difficult mathematics concepts within the topic. From the results of the survey, it appears that this area merits a greater emphasis even within a methodology course and the assumption that graduates with university level mathematics have a sufficient understanding of mathematics concepts in order to teach secondary mathematics and should

therefore only need methodology is flawed.

The study is not completed yet as the verbal responses have to be more carefully analysed and interviews conducted. However, these preliminary results are helpful in providing a profile of the newly graduated mathematics teachers and their needs for further professional development.

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