THE ATTITUDES AND PRACTICES OF STUDENT TEACHERS OF PRIMARY SCHOOL MATHEMATICS

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(Published in A. Borbas Ed. *Proceedings of 12th International Conference on the Psychology of Mathematics Education,* Hungary, July 1988, Volume 1, Veszprem, Hungary, OOK., 1988: 288-295.)

A group of student primary school teachers were studied with regard to : Knowledge of mathematics (subject specialism), Attitude to mathematics, displayed Confidence and Liking of mathematics teaching (during practice), and Approach to mathematics teaching (open vs. closed). The Mathematics specialists tended to have positive attitudes to mathematics, and to its teaching, but varied in their approach to teaching mathematics: only 40% adopt a creative, problem solving approach. The students with low levels of knowledge of mathematics are more varied in their responses. It seems that attitudes to mathematics are less significant for these students than attitudes to teaching mathematics, which (latter) correlate with teaching approach.

It is a long established belief that psychological elements in the teacher play a central role in the teaching of mathematics. In particular, many researchers have held the view that there is an important relationship between the attitudes of a teacher, especially their attitudes to mathematics, and the effectiveness or quality of their teaching of mathematics (Bishop and Nickson 1983).

The argument is that teacher attitudes influence student attitudes (Aiken 1970, Larson 1983), and that student attitudes have a powerful influence on learning (Evans 1965, Khan and Weiss 1973). Indeed a number of researchers have found a significant correlation between teacher attitude and student achievement (Begle 1979, Bishop and Nickson 1983, Schofield 1981)

The problem of poor attitudes can be particularly acute in the case of primary or elementary school teachers (particularly those who are not mathematics specialists). For teachers of younger students tend to have poorer attitudes than those teaching older or intermediate aged students (Early 1970, Raines 1971). "The result is that teachers who can influence student attitudes and achievement in their formative stages may be those that have the poorest attitudes themselves." (Kulm 1980, p. 372)

Research has shown that the picture is more complex than this simple argument suggests, for two reasons. First of all, although many researchers have confirmed the existence of a relationship, the correlation between mathematical attitude and achievement is weak (Begle 1979 , Bell et al 1983).

The second source of complexity is the multi-dimensional nature of attitude to mathematics. Recent attitude research distinguishes a number of different components of attitude (including liking & enjoyment, difficulty, confidence, anxiety, valuing) to mathematics as a whole, as well as to specific mathematical topics (Aiken 1976, Kulm 1980, Bell et al 1983). In addition to these attitudes to mathematics there is also the teacher's attitude to the teaching of mathematics. A priori there is every reason to believe that attitude to teaching mathematics is just as important a factor in contributing to the development of student attitudes and achievement in mathematics. However the research in this area is far more limited.

On the basis of these considerations a question arises: what is the relationship between attitudes to mathematics and attitudes to its teaching?

In addition to the ever-present interest in the achievement outcomes of mathematics teaching, the Nineteen Eighties has seen an increased concern with the approach or style of mathematics teaching. Official bodies such as the NCTM (1980) in the USA and the Cockcroft Committee (1982) in the U.K. have strongly recommended the adoption of a creative, problem-solving approach to the mathematics teaching, on the grounds that this enhances attitudes, understanding and flexibility of thought. This raises a second question: to what extent are student teachers' attitudes related to their style of teaching mathematics?

THE STUDY

This is a report of an investigation of a group of student primary school teachers, with regard to their attitudes towards mathematics, and their manifested attitudes and practices in teaching mathematics. In particular the study addresses many of the issues discussed above. The investigation focuses on a number of variables:

1. knowledge of mathematics (on the basis of student course specialism)
2. attitude towards mathematics (a combination of their liking of the subject and confidence in their mathematical ability)
3. Liking and enthusiasm for the teaching of mathematics, and
4. Confidence in their ability to teach mathematics (as demonstrated during their first period of practice teaching)
5. Teaching approach in mathematics (creative and exploratory versus narrow and basic computation skills oriented)

The sample consists of 30 second year students attending a four year Bachelor of Education (B.Ed.) Degree course, for intending primary school teachers (teaching age range 7 - 12), at an English university. In addition to their primary teaching studies, each student specialises in an academic topic. Ten of the students study Mathematics or Science as their main academic subject (henceforth, the M&S students). The remaining 20 subjects are specialist students of French, History or English specialists (the FH&E students). The sample consists of the 30 students whose supervising tutors on teaching practice co-operated by completing a mathematics teaching observation schedule.

KNOWLEDGE OF MATHEMATICS

The M&S students all (with the exception of a single S student) have a pass in Mathematics at GCE 'A' level, which indicates successful specialist study of mathematics (including calculus) from 16 to 18 years of age. In addition, the M&S students study mathematics as their main academic subject in the B.Ed. course (M), or in support of their main Science course (S).

None of the FH&E students (with the exception of a single F student) have a pass in Mathematics at GCE 'A' level. None of them studies mathematics as part of their B.Ed. course.

All of the students have passed Mathematics at GCE 'O' level (at age 16), as it is a statutory requirement for entry into a teacher education course. They have also all taken a Mathematics Curriculum course on the teaching of Mathematics in the primary school as part of their B.Ed. studies.

Overall, whilst all of the sample have studied mathematics to age 16, in general it is only the M&S students who have continued with two further years of successful further specialist study of mathematics, prior to entering university.

ATTITUDE TO MATHEMATICS

Attitudes were measured by means of a 15 item self report questionnaire, adapted from Dutton (1965). It is made up of positive and negative statements concerning liking of and enthusiasm for mathematics, and confidence in own mathematical ability and knowledge. The overall summed score from the questionnaire is taken to give an undifferentiated measure of 'attitude towards mathematics (as a whole)'.

Each item is scored out of 5, resulting in a range of marks from 15 to 75. The median score is 45, and so a score of between 40 and 50 is taken as indicating a neutral attitude to mathematics. Scores of over 50 (60) are taken as indicating a positive (very positive, respectively) attitude to mathematics.

Likewise, scores of under 40 (30) indicate a negative (very negative, respectively) attitude to mathematics.

The questionnaire was administered a number of times (4) during the 18 months of the course to the full cohort of 51 students on the course. However only the data on the 30 students who were observed teaching mathematics is reported here.

For these students, as for the whole cohort, the overall pattern of attitudes remained more or less constant over the four testings; there was no significant shift in attitudes to mathematics. Thus, for example, the test-retest reliability of the last two testings is 0.86. The responses of the 30 students to the questionnaire (fourth testing) are shown in Table 1 below.

TABLE 1 : Student Teachers' Attitudes to Mathematics

STUDENT GROUP	SIZE	MEAN SCORE	S.D.	INTERPRETATION
OVERALL	30	48.2	10.8	NEUTRAL
FH&E	20	44.1	10.2	NEUTRAL
M&S	10	56.6	6.5	POSITIVE

As the large standard deviations in Table 1 suggest, there is a considerable spread in the attitude scores, particularly in the FH&E students. This is shown in Table 2, below.

TABLE 2: The Distribution of Attitudes to Mathematics

ATTITUDE TO MATHEMATICS	ALL (30) STUDENTS	NUMBERS OF M&S STUDENTS	NUMBERS OF FH&E STUDENTS
VERY POSITIVE [>60]	3 (10%)	3 (30%)	0 (0%)
POSITIVE [>50]	12 (40%)	6 (60%)	6 (30%)
NEUTRAL [40 - 50]	7 (23%)	1 (10%)	6 (30%)

NEGATIVE [<40]	6 (20%)	0 (0%)	6 (30%)
VERY NEGATIVE [<30]	2 (7%)	0 (0%)	2 (10%)

Table 2 shows that one half of the 30 students have a positive attitude to mathematics (and, of course, that the other half of the students does not). One quarter of the students have a negative attitude to mathematics.

In terms of subject groupings, it can be said that almost all of the M&S students (90%) have a positive attitude to mathematics, and none have a negative attitude. The picture is quite different for the FH&E students; only 30% of the students have a positive attitude to mathematics, leaving 70% without a positive attitude to mathematics (a subject they will be required to teach to children). Fully 40% of these students have a negative attitude to mathematics

OBSERVATIONS OF THE STUDENTS' TEACHING

During the first block teaching practice (of five weeks duration) in primary schools all of the student teachers taught mathematics for a significant proportion of their time (a mean of 3.5 hours out of 15 hours per week: 23% of their teaching time, during the last few weeks of the teaching practice). Supervising tutors were asked to complete a questionnaire on the students' teaching of Mathematics, in consultation with the students, if they so desired (which often occurred when the tutors had been present at very few Mathematics lessons). The questionnaire consisted of 16 items, each with a 4 point scale to indicate the frequency, where the item describes a practice, or agreement, where the item describes a characteristic of the student teacher. The questionnaire focused on a number of factors , including the student teachers':

1. Confidence in teaching mathematics

2. Liking and enthusiasm for the teaching of mathematics (this includes professed liking, as well as enthusiasm displayed during the teaching of mathematics)

3. Teaching approach in mathematics: creative and exploratory versus narrow and basic computation skills oriented, as evidenced by the use of problem solving and investigation tasks, the use and encouragement of exploratory discussion of mathematical ideas, the degree of concentration on basic computational skills and the teaching that there is a single correct method for each mathematical task.

Observational data for these components has been combined by scoring each questionnaire item from 1 to 4 according to the tutor's response (or 4 to 1, if the item is reversed), and then taking means corresponding to groups 1, 2 & 3 above. A summary of the tutors' observations of the student teachers' mathematics teaching is shown in Table 3.

TABLE 3: Observational Data on Students' Teaching of Mathematics

	ALL STUDENTS	M&S STUDENTS	FH&E STUDENTS
CONFIDENCE IN TEACHING MATHS			
Confident in Maths Teaching	20 (67%)	9 (90%)	11 (55%)
Lacking in Confidence	10 (33%)	1 (10%)	9 (45%)
LIKING OF MATHS TEACHING			
Like of Maths Teaching	21 (70%)	8 (80%)	13 (65%)
Neutral	2 (7%)	0 (0%)	2 (10%)
Dislike of Maths Teaching	7 (23%)	2 (20%)	5 (25%)
APPROACH IN TEACHING MATHS			
Creative & Exploratory	8 (27%)	4 (40%)	4 (20%)
Intermediate in Approach	16 (53%)	3 (30%)	13 (65%)
Narrow & Computation Oriented	6 (20%)	3 (30%)	3 (15%)

Table 3 shows that two thirds of all of the student teachers are confident about their teaching of mathematics, and this includes nearly all of the M&S students (90%), but only just over one half of the other students (55%). Almost one half of the non Mathematics and Science specialists (45%) lack confidence in their

ability to teach mathematics, an activity which is likely to occupy a large part of their professional life.

Again, about two thirds of all of the students (70%) like, or display enthusiasm whilst teaching mathematics, and this includes most of the M&S students (80%) and about two thirds of the other students (65%). About one quarter of all of the students dislike the teaching of mathematics, and do not display enthusiasm while teaching it, whatever their subject specialism (20% of M&S students and 25% of FH&E students).

With regard to their teaching approach in mathematics, about one quarter (27%) of the full group of students employ a creative and exploratory approach, one fifth (20%) employ a narrow, basic computational skills oriented approach, and one half are intermediate in approach (53%). The proportions of student teachers employing the approaches vary according to teaching specialism groupings. More (65%) of the FH&E students employ an intermediate approach, and less employ a creative, exploratory approach (20%) or a narrow, basic skills approach (15%). The teaching approaches are more evenly distributed among the M&S students: 40% employ a creative, exploratory approach; 30% an intermediate approach; and 30% a narrow, basic skills approach. Thus a greater proportion of the M&S students employ one of the more extreme (that is, more strongly characterised) approaches to the teaching of mathematics, namely 70% (M&S) as opposed to 35% (FH&E).

DISCUSSION: THE RELATIONSHIPS BETWEEN THE VARIABLES

With regard to students with high levels of knowledge of mathematics (namely the M&S students) it can be said that these students also tend to have positive attitudes to mathematics, tend to be confident with regard to their ability to teach mathematics, and tend to like and display enthusiasm during the teaching of mathematics. However, these students do not tend to adopt a creative, exploratory approach to the teaching of mathematics, only a sizeable minority (40%) of them do. Another sizeable minority (30%) adopt a narrow, basic computation skills approach to the teaching of mathematics. This second grouping does not consist of those M&S students with less positive attitudes, lower levels of confidence in, or liking of teaching mathematics. On the contrary, the students with the most positive attitude to mathematics and the student with the highest level of confidence in teaching mathematics belong to this group. Thus, to the extent that any valid conclusions can be drawn from such a small sample, it appears that for some students, the teaching approach adopted is unrelated to the other variables considered.

A conjectured explanation for this lack of correlation involves the students' conceptions or beliefs concerning the nature of mathematics. M&S students are likely to view mathematics either as a precise, structured body of truths and methods, or as a more dynamic, creative problem solving activity (or as some

combination of the two). Either way, the students can have positive attitudes and a liking of, and confidence in, their teaching of mathematics. What is likely to vary is their teaching approach, students with the former view may tend to approach school mathematics as a rather narrow, computational oriented activity. The latter view may lead to a creative, exploratory approach to the teaching of mathematics (Lerman 1983, Thompson 1984, Ernest 1987). This conjecture accounts for the varying teaching approaches of the M&S students. Needless to say, it remains speculation and requires further empirical investigation (currently in progress).

With regard to students with low levels of knowledge of mathematics (namely the FH&E students) it cannot be said there is any fixed pattern of attitudes to mathematics, except that more are negative or neutral (70%) than positive (30%). Just over half (55%) are confident of their ability to teach mathematics, but there is no correlation between confidence in teaching mathematics and attitude to mathematics. Two thirds of these students like mathematics teaching, but there is no correlation between liking of teaching and attitude to mathematics or confidence in teaching. When liking of teaching scores are plotted against attitude to mathematics scores, the result is a fairly random scatter diagram, in which the lack of correlation is evident (for both groups of students). With regard to teaching approach, there is a correlation with liking of teaching mathematics (for FH&E students only): a creative, exploratory approach to the teaching of mathematics is correlated to some extent with the students' liking and displayed enthusiasm in the teaching of mathematics. However this correlation is not statistically significant (Pearson's product moment coefficient takes the value 0.32, which is not significant at the 5% level, using the F-test).

The FH&E students are not likely to have conceptions of the nature of mathematics as potent as those of the M&S students. Thus they are unlikely to have the aesthetic that can accompany a static, product oriented view of mathematics to sustain them. Rather they are likely to adopt a narrow, computation based approach to teaching mathematics as an unimaginative approach to a subject they are unenthusiastic about, rather than as an expression of an underlying philosophy of mathematics. The association of a creative, exploratory approach with liking and enthusiasm for teaching is no surprise, for it takes enthusiasm to be creative, and it is not easy to be imaginative in planning exploratory mathematics lessons without a liking for the teaching of mathematics.

What this study suggests is that attitude to mathematics may be less important than many previous authors have assumed. Mathematics specialists do have a positive attitude to mathematics, but their knowledge of mathematics is likely to lie behind this, and may be the more important factor. For teachers with lower levels of mathematical knowledge attitudes to the teaching of mathematics may be the more important attitudes, as it is these that are associated with a more creative, problem solving approach to mathematics, in the present study.

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