Measuring Attitudes towards Mathematics in Early Childhood and Primary Teacher Education

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Changes in attitude have been measured over a semester of mathematics in the first year of Early Childhood and Primary teacher training. The unit of study is not a curriculum unit, is taught by mathematicians and explores mathematical ideas and experiences. The Fennema-Sherman Attitudes Scale was used to measure changes in *confidence, effectance motivation,* and *usefulness*. Analysis of the results indicates a challenging outcome - the only significant change was a drop in their perception of the usefulness of mathematics.

1 Introduction

A unit of study in mathematics, designed for Early Childhood (including Childcare) and Primary trainees, has been evaluated specifically to measure changes in attitude which occur during the semester. The unit of study is unusual in that it has been designed and is lectured by mathematicians from the science faculty, with advice and workshop support provided by the education faculty. The unit was designed for four main purposes: (i) to develop an awareness of a range of mathematical ideas and experiences not usually studied at school, (ii) to have some success in doing mathematics, (iii) to instill confidence in doing mathematics, and (iv) to develop a positive attitude towards mathematics. Teaching mathematics to such a diverse group can be a daunting task.

Points (i) and (ii), above, are readily measured and evaluated using assignment, workshop, and examination results. However, points (iii) and (iv) above reflect attitudinal factors which are just as important to measure if the unit is to be evaluated for effectiveness and subsequent development. The instrument used to do this was the Fennema-Sherman Attitudes Scale (Fennema & Sherman, 1976) and was administered during the first and last week of Semester 2, 1997. This instrument was used to measure changes in attitude to mathematics in relation to the three factors of *confidence*, *effectance motivation*, and *usefulness*. Note that effectance motivation is a measure of attitude to problem solving and ranges from a lack of involvement through to active enjoyment in seeking challenges.

The unit of study, *Mathematics for Teachers,* is a compulsory first year unit in the three year Bachelor of Early Childhood Studies (childcare) and the four year Bachelor of Education (primary and early childhood). It includes a study of topics selected from: mathematical reasoning, logic, numeration systems, elementary number theory, geometry, and topology, with problem solving providing an overall theme. Weekly contact hours for a student involve two hours of lectures and two hours of practical workshop activities which include hands-on experience with materials that reinforce the topics. Assessment of the unit is by (i) written assignment, (ii) participation in the workshop (problem solving tasks, group work, and group discussions), and (iii) final examination.

2 Motivation

Against broad statistics which reveal that mathematics is often viewed negatively by scholars (Mullis, 1992) is the concern about teacher attitudes to mathematics. Their beliefs and conceptions not only play a role in the methods of instruction of teachers (Thompson, 1992), but are linked to the attitudes and achievement of their pupils (Kulm, 1980). Reports of negative attitudes of prospective teachers towards mathematics, for example in Carroll (1994) and Way and Relich (1993), are therefore cause for concern.

Some studies indicate that it is difficult to change those attitudes. Schuck (1996) describes the beliefs and attitudes, which students bring with them into pre-service training, as chains that are not easily broken. Way and Relich (1993) suggest that perhaps attitudinal changes induced in pre-service training may not be enduring.

Nevertheless, studies like those of Bobis & Cusworth (1997), Mayers (1994), and Perry et al (1994) give hope that the nature of tertiary exposure to mathematics can indeed play a role in improving attitudes. This indicates that we should seek opportunities for fostering improvement, and that there is reason to be positive about the role tertiary mathematics studies can play. Furthermore, we must accept responsibility for ensuring that such studies do not reinforce any existing negative attitudes.

With these goals in mind this early quantitative study was undertaken. The motives were therefore:

- to establish a clear profile of the students in the *Mathematics for Teachers* unit at the outset: age, gender, mathematical background, intended level of teaching, and most importantly, their attitudes towards mathematics;
- to measure any change in those attitudes at the end of this unit;
- to establish any significant relationships between those attitudes and other factors;
- to identify directions the unit should take to support improvement in attitudes; and
- to pave the way for follow-up exploration, both quantitative and qualitative, based on interviews and case studies.

3 Methodology

To measure these attitudes a questionnaire was administrated in the first lecture of the semester and another one in the last lecture of the semester. The initial questionnaire was in two parts. The first covered demographic information such as age, gender, degree in which enrolled, high school mathematics level and two other questions of interest: the grade the student expected to receive and if they had had a choice would they study *Mathematics for Teachers*. The age was recorded in intervals of 17-18 (school leavers), 19-23, and 24 and over, representing the mature age students.

The second section contained a measure of the student's attitude to mathematics. Because of the impact of the Fennema-Sherman scales, which have "been felt widely in all research on attitudes toward mathematics" (McLeod, 1994, p639), a selection of these was chosen. *Mathematics for Teachers* is neither a methods of teaching nor a curriculum unit and we specifically wished to measure the changes in attitudes associated with studying this unit. It was decided not to use any of the available scales of Ludlow and Bell (1996),

Nisbet (1991) or Relich, Way and Martin (1994) as these scales have been specifically designed to measure attitude to teaching mathematics as well as measuring an attitude to mathematics. The scales of *Confidence in Learning Mathematics*, *Effectance Motivation in Mathematics* and *Usefulness of Mathematics Scale* were chosen for the following reasons.

Prior experiences in mathematics form the strongest "chain" that Schuck (1996) sees as responsible for inhibiting a student's progress in mathematics. Bodis and Cusworth (1997) and Sax (1994) have noted that previous mathematical experience has an impact on a student's confidence in mathematics. McLeod (1994) feels confidence in learning mathematics can also indicate a "belief about oneself" (p641), whereas Meyer & Koehler (1990) and Relich, Way and Martin (1994) see confidence as being a part of a student's self-concept of mathematics. As such the scale measuring *Confidence in Learning Mathematics* was included.

The area of emotions are generally neglected in affective domain research, according to McLeod (1994). The "Aha!" experience (McLeod, 1994) to problem solving is the reaction all educators would like to see in their students, but unfortunately most students do not see mathematics as a subject beyond arithmetic or a set of rules that will quickly give a correct answer. (Carroll, 1994; McLeod, 1994; Schuck, 1996; Southwell & Khamis, 1994). The lack of perseverance, motivation and involvement in problem solving is cause for concern. Therefore the scale *Effectance Motivation in Mathematics* was selected.

Mathematics participation is strongly associated with a perception of usefulness of mathematics (Carroll, 1994; Leder, 1992; Meyer & Koehler, 1990; Schuck, 1996). Armstrong & Price (in Leder, 1992) found that usefulness of mathematics was the most important variable for high school senior females. The occupational plans of students also reflect their perception of usefulness of mathematics (Leder, 1992). Since the pre-service teacher's course has a high proportion of females of which a large number here are enrolled in Early Childhood and Childcare degrees, the effect of usefulness of mathematics should not be ignored. Consequently the *Usefulness of Mathematics* scale was included.

Some wording was changed in the scales because the educational institution is a university, not a school. The follow up questionnaire contained: the grade expected question, the question of choice in studying the unit, and the three attitude scales.

The student's total for each scale on each survey was considered to be a separate variable. The difference between each scale total was to be measured and this difference tested for any significance. Demographic variables were also used as factors to determine if there was any difference between or within the groups of students (Kulm, 1980).

4 Data and Findings

There were 298 students originally enrolled in *Mathematics for Teachers* for the semester. A total of 237 completed the pre-test survey at the beginning of the semester. Only 160 students completed the post-test survey. Those who did both surveys numbered 135 which represented 45% of the population.

Reliability tests, using Cronbach alpha, gave values of 0.94, 0.90 and 0.87 for the pre-survey confidence, effectance motivation and usefulness scales respectively and 0.95, 0.91 and 0.90 for the same respective post-survey scales.

There was no significant difference between the respondents who completed both surveys and those who completed only one survey. Hence the rest of the discussion will be concerned with those students who completed both surveys. It is felt that this group is representative of the population both demographically and attitudinally.

As in most primary teaching courses there is a large number of females compared with males. Representing 86% of the 135 respondents, there are 116 females in the survey.

The group has an age distribution as shown in Figure 1. The majority of students are school leavers and a fifth are mature age students.

Figure 1. Age Distribution in Years

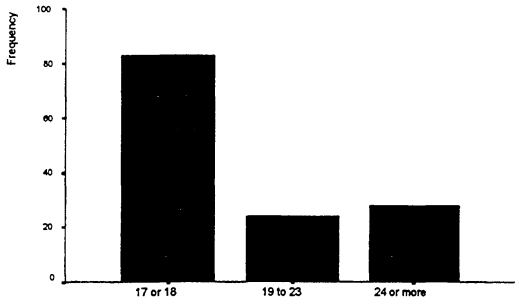
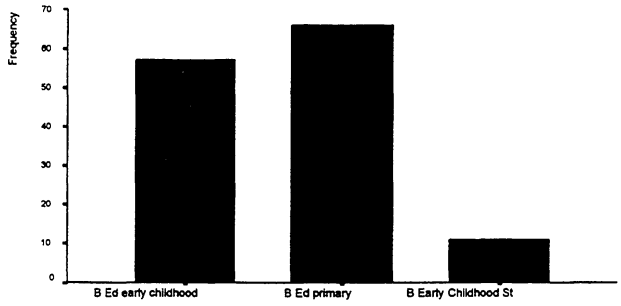


Figure 2. Degree Distribution



There are similar numbers enrolled in the Bachelor of Education (early childhood) and in Bachelor of Education (primary). A small number are studying for a Bachelor of Early Childhood Studies. The actual figures are represented in Figure 2.

Table 1. Final Grade Received

Grade	Frequency		Percentage	
HD	9	*(13)	6.7	(4.4)
A	34	(46)	25.2	(15.4)
B	55	(98)	40.7	(32.9)
C	28	(68)	20.7	(22.8)
F	9	(47)	6.7	(15.8)
Dropped	0	(26)	0.0	(8.7)
Total	135	(298)	100.	(100)

*Corresponding figures for the whole group are given in brackets.

Table 1 and Figure 3 display the semester grades of the students who responded to both surveys. The values in brackets in Table 1 give the grades and percentages for the entire *Mathematics for Teachers* group. The respondents have a higher proportion in each grade except those who failed.

Figure 3. Final Grade Received

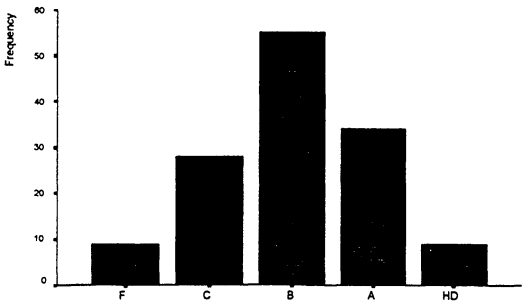
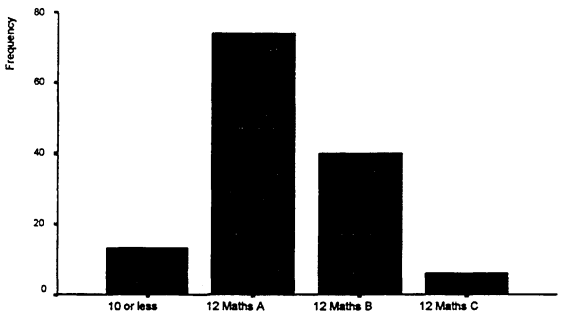


Figure 4. Highest School Mathematics Level



Most of the students have completed Year 12 Mathematics A (Figure 4). Of the thirteen who have Year 10 or less mathematics, eleven were in the 24 or over age group.

Missing data were randomly scattered throughout the scale variables and cases and deletion of all affected cases would have meant a large loss of data. The missing data were replaced by the conservative estimate of the variable mean (Tabachnik & Fidell,1989).

Table 2 shows the means and standard deviations of the total scores for each scale on the pre-survey and the post-survey and the corresponding statistics of the difference between the pre- and post-totals . There was little change.

Table 2. Statistics of the Pre- and Post- Surveys and the Difference Distributions

		Pre-Survey		Post-Survey		Difference	
Scale	N	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
Confidence	135	37.34	9.62	37.46	10.62	0.12	6.23
Effectance	135	37.51	8.07	37.46	10.62	-0.51	6.31
Usefulness	135	46.42	6.64	45.17	7.66	-1.25	6.10

The confidence scale shows a small, non-significant increase in confidence over the semester. However examination of the confidence distribution, Figure 5, shows an influential score. For some wonderful student his/her confidence changed by 24 points. (If only we could always have this effect!) If this score is eliminated from the sample the mean is –0.07; so virtually no change occurred. This accords with the view that confidence or self-concept is resistant to change (Way & Relich, 1993, Meyer & Koehler, 1990).

Figure 5. Difference in confidence

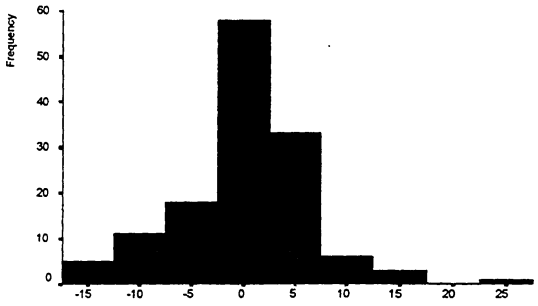
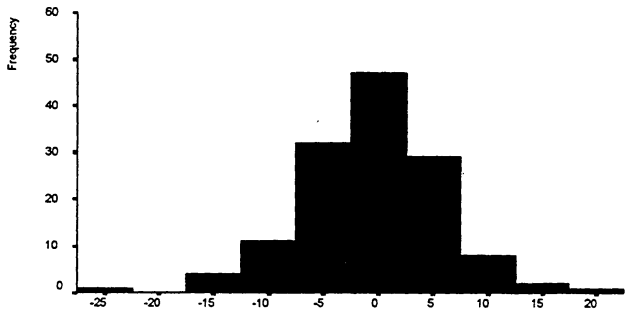
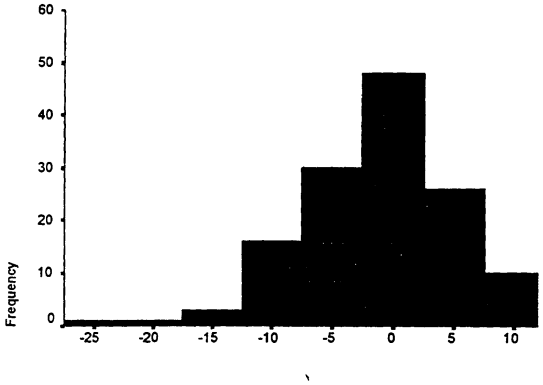


Figure 6. Difference in Effectance Motivation



The effectance motivation scale shows a decrease in attitude although it is small and non-significant. The large negative score in Figure 6. does not have much influence on the mean.

Figure 7. Difference in Usefulness



The distribution of the difference in usefulness in Figure 7. shows a negative skewness with a mean of -1.25.The sample size is large enough for the skewness not to invalidate the significance found in this difference ($t = -2386$, $p = 0.018$). This result is supportive of the usefulness findings of Carroll, (1994), Meyer & Koehler (1990), Schuck (1996) that mathematics needs to be seen as useful.

Many of the demographic variables can be used as factors in the analysis of the attitude data. Gender cannot be ignored when discussing attitudes to mathematics; for example, Fennema (1976), Leder (1992), Meyer & Koehler (1990). For this student group, however, there was no significant gender difference on any of the scales.

The scale mean differences, grouped according to age, are given in Table 3. For the two younger age groups the all of the mean differences are non-significant and negative. Though not significant, the positive means for the confidence and effectance motivation scales give encouraging results in the 24 or over group. The student who had a difference of 24 is a mature aged student and as such has inflated the confidence mean. Elimination of this score still gave a positive, but small, difference mean of 0.81.

Table 3. Scale Difference Means by Age in Years

Age Group:	17 & 18		19 to 23		24 or over	
Scale	N	Mean	N	Mean	N	Mean
Confidence	83	-0.31	24	-0.20	28	1.67
Effectance Motivation	83	-1.07	24	-1.33	28	1.86
Usefulness	83	-1.19	24	-1.97	28	-0.83

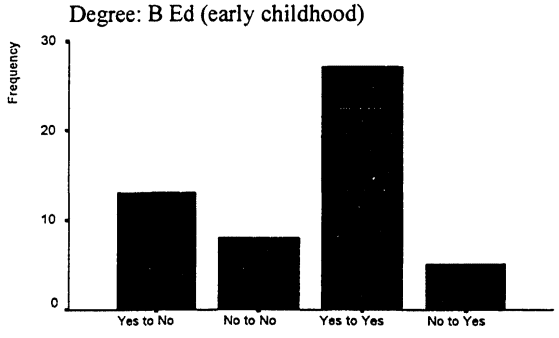
Is there a difference in the mathematical attitudes associated with the course in which the students were enrolled? Table 4 shows the scale difference means by degree course. Again there was no significant difference between the groups although usefulness shows an area of interest with $p = 0.10$. Within the groups, the B.Ed.(early childhood) usefulness data gave strong evidence of a difference in attitude ($t = -3.024$, $p = 0.004$); the difference being negative.

Table 4. Scale Difference Means by Degree

Degree:	B.Ed.(e.child)		B.Ed.(primary)		B.Early Child.St.	
Scale	N	Mean	N	Mean	N	Mean
Confidence	57	-0.10	66	0.33	11	0.27
Effectance motivation	57	-1.29	66	0.35	11	-1.38
Usefulness	57	-2.53	66	-0.33	11	0.09

In both surveys students were asked to indicate if they had a choice would they study the unit *Mathematics for Teachers*. As perceived usefulness influences participation and since the attitude of usefulness of mathematics has become an area of concern their change in choice could also be a reflection of these negative attitudes.

Figure 8. Change in Choice of Studying *Mathematics for Teachers*



Of the 92 students in the total group who, at the beginning of the semester, indicated they would choose to study *Mathematics for Teachers*, twenty-one changed their mind from Yes to No. Forty students in the B.Ed. (early childhood), Figure 8, indicated they would study the unit in the pre-survey. Thirteen changed their mind, a proportion of 33%, in line with the change in their attitude to the usefulness of mathematics.

5 Summary and Conclusions

To measure the change in attitude to mathematics of a group of pre-service teachers while studying the unit *Mathematics for Teachers* the three Fennema-Sherman scales of *Confidence in Learning Mathematics*, *Effectance Motivation in Mathematics,* and *Usefulness of Mathematics* scale were administrated at the beginning and end of the semester.

No significant change in attitudes for the *confidence* or *effectance motivation* scales across the whole sample or within any of the three groups of gender, age and degree was found. This is supported by those studies which claim attitudes are indeed difficult to change, even within strongly supported environments (Carroll, 1994; Meyer & Koehler, 1990; Schuck, 1996). It is encouraging, however, that there is little or no drop in these scales.

It was through the negative attitude change in the *usefulness* scale that students sent a message. The group as a whole produced a small negative, but significant, difference in attitude. However the loudest message, though not unexpectedly, was sent by the Bachelor of Education (early childhood) students whose scores gave strong statistical evidence of an attitude change, albeit negative. This group also gave the highest proportion of students, who over the semester, changed their mind in their choice to study this unit.

This drop in the perception of *usefulness* is in line with the broadly held view that the mathematics taught must be seen as useful to the teachers in training (Carroll, 1994; Mayers, 1994; Schuck, 1996). But it presents the most positive challenge! It offers opportunity to address improvement in the unit which may well induce more positive results. Certainly it is the intention to try to establish what indeed those students who expressed a positive attitude about *usefulness* do consider useful, and build upon that. It is not yet clear whether the perception of *usefulness* pertains to their classroom needs or to the wider uses of mathematics in the community. Interviews should prove illuminating. So too might involving the students of the group in the research; students interviewing each other in a search for what is considered useful about mathematics in this context (Schuck, 1996). Revision of the unit *Mathematics for Teachers* can then be carried out effectively.

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