The Effect Of Gender And Fluency In English On The Mathematical Confidence And Achievement Of Adults In A Realistic Mathematics Course

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Abstract

This research project aimed to explore the reactions of students to the style of teaching and assessment in a year-long mathematics paper (course) at the University of Auckland. This paper, Mathematics 1, was established to attract and help students returning to mathematics after a break, or to help students who have not succeeded in previous mathematics study. It aims to build the confidence of students by providing the opportunity for them to engage in mathematical modelling in a variety of contexts. A preliminary survey was undertaken in 1995 to explore students' reactions to the paper and the findings from this survey are presented. A comparison was made of students' mathematical confidence, how relevant they found the approach, and their achievement in the paper. Results indicate that for students who are fluent in English, a higher proportion of females than males indicated a definite increase in mathematical confidence. In comparison, for students who are not very fluent in English, a reasonably high proportion were negative about the approach in the paper, as well as the effect on their mathematical confidence, and this group did not achieve as well as those who were fluent in English.

Introduction

In common with many university Departments of Mathematics, that at the University of Auckland has catered for students who successfully passed school examinations in year 12 (Form 7, age 18 years) and who wanted to major in the mathematical or physical sciences. However, within the last decade, the percentage of students without the background knowledge for this level of study in mathematics has risen markedly. To meet the needs of students who had been away from the formal study of mathematics for some time a new paper (Mathematics 1) was designed. (The term 'paper' is used to describe a semester, or year, long study of a subject, and studying seven papers is a normal full time study load for a year of study for a degree.)

The approach to Mathematics 1, which was taught for the first time in 1994, is a significant departure from the more traditional content-based presentations of mathematics in that it aims to integrate mathematical process and content. Topics discussed are social themes, for example, environmental issues, maps, packaging and

medicine. Wherever possible students are encouraged to work together on open-ended tasks, investigations of mathematical situations, and to communicate mathematically, in order to increase their mathematical confidence and competence.

Theoretical Background

The underlying rationale for Mathematics 1 is that mathematics is a changing product of human creation, and is similar to that of the *realistic mathematics* education approach in the Netherlands (de Lange, 1993). The essential aspects of this approach are that of *mathematisation* and the role of context. A "real world" situation is initially explored intuitively, to organise and structure problems and discover their mathematical aspects.

In Mathematics 1 the importance of letting students develop their own mathematical understandings is emphasized, however the success of this approach may depend on the appropriateness of the realistic contexts for all students. Helme (1994), in her study of adult mathematics students, found that "contextual barriers" were imposed by contexts which were unfamiliar to the students and therefore alienating for them, that all students were not motivated by context, and that some preferred familiar contexts and some unfamiliar ones. Lajoie (1995) emphasises that care must be taken in the development of real world problems to ensure no cultural bias is introduced.

Research over the last two decades has contributed much to our knowledge of the relationship between gender and mathematics. It appears that gender differences in mathematics achievement are declining to a minimal level although they still occur, beginning at adolescence, in areas like "complex problem solving". However, these results are class and ethnicity specific (Campbell, 1995:228). Fennema (1995:25) mentioned that consistent findings from research completed amongst high school students in the United States in the 1980's found that "young women did not believe that mathematics was particularly useful and tended to have less confidence in themselves as learners of mathematics". A study by Vale (1993:566), based on the results of the new Victorian Certificate of Education (VCE, introduced in 1991) where the mathematics assessment practices were broadened to include more modes of assessing student learning, indicated that this was the "first Australian study to establish a consistent pattern of higher than average achievement in mathematics by females". She found that females "performed better than males on investigative projects and non-routine problem solving".

Female students may respond positively to the realistic investigative nature of the tasks in Mathematics 1 and to the cooperative learning in groups (Burton, 1987; Fennema, 1995). The task contexts, however, may be more personally meaningful to one group than another (Heckman & Weissglass, 1994), or could act as a "contextual barrier" (Helme, 1994). All of these authors did their research with students raised in a Western tradition. There is no evidence to indicate that these results would also be similar for students with different cultural and educational backgrounds, particularly students from South East Asia. Literature about the interaction between gender and fluency in English has not been found to date. This study explores how females and males react to the

realistic investigative and interactive approach of Mathematics 1, and also how fluency in English affects this reaction to the curriculum within each gender group.

Method

An instrument was designed to gather information from the students in Mathematics 1 and was administered in 1995 in late March (pretest, one month after lectures had commenced for the year) and October (posttest, in the final week of lectures). Demographic variables collected included each student's age, gender, and fluency in English. Open questions were included in both the pretest and the posttest.

Forty-four students (out of the 65 who finished Mathematics 1) completed the posttest questionnaire. Analyses of a pilot survey undertaken in 1994 were published previously (Miller-Reilly, 1995; Miller-Reilly, 1994). Some of the preliminary findings from the 1995 survey are also published (Miller-Reilly, 1996; Miller-Reilly, 1997).

Results

This paper is a short preliminary analysis of some of the 1995 posttest data, focussing on gender and on fluency in English. Of the 44 students in the posttest group, 61% were female. More than half the females, but only 12% (n=2) of the males, report moderate or little fluency in English. Pass rates are higher for students who are fluent in English, both female and male (92% and 85% respectively), whereas the pass rate for females who had moderate or little fluency in English is 64%.

One of the open questions at the posttest was *What do you think about the maths you have done in this paper?* The responses to this question were content analysed and post coded. The percentage of students' answers in each of the response categories within each demographic group is shown in Table 1.

Table 1: Response categories to the open question *What do you think about the maths you have done in this paper?* by Gender and Fluency in English

		Very good. Learned more. Thinking more mathematically.	Relevant. Interesting. Practical.	Negative response	No answer
Female	Fluent in English	31%	46%	15%	8%
	Moderate or little fluency in English	50%	8%	21%	21%
Male*	Fluent in English	60%	26%	7%	7%

* Because there are only two male students who are not fluent in English, no percentages are given for that group.

Note that almost half the females who were fluent in English mention the relevant and interesting nature of the paper. Only one quarter of the males who are fluent in English and less than a tenth of females who have moderate or little fluency in English commented on this aspect. However, half of the females who have moderate or little fluency in English and more than half of the males who are fluent in English felt that they were learning more or that the paper was very good, the largest response category for these two groups. Almost a third of the females who are fluent in English respond in this way also. Nearly half (42%) of the females who were not fluent in English either did not respond, maybe because they could not understand the question, or gave negative responses.

Another of the open questions at the posttest was *Has this paper affected your mathematical confidence?* Table 2 lists the percentage of females and males, by fluency in English, indicating either a definite increase, some increase or no increase in mathematical confidence.

Table 2: Response categories to the open question *Has this paper affected your mathematical confidence?* by Gender and Fluency in English

		Definite increase in confidence.	Some increase in confidence	Already confident or too easy.	No increase in confidence	No answer
Female	Fluent in English	62%	0%	23%	15%	0%
	Moderate or little fluency	21%	14%	14%	14%	36%
Male	Fluent in English	47%	20%	13%	7%	13%

Note that one third of the females who had moderate or little fluency in English indicate increased mathematical confidence, compared to about two thirds of the other two groups, males and females who are fluent in English. The highest proportion who indicate a definite increase in mathematical confidence are females who are fluent in English, 62%, compared to 47% for males who are fluent in English and 21% for females not fluent in English. Over one third of the females who had moderate or little fluency in English do not respond to this question, compared to 0% and 13% in the other two groups.

Beliefs about the Learning of Mathematics

To help interpret the differences between the above groups in responses to the open questions analysed, a comparison was made between their responses to several statements designed to reflect students' beliefs about the learning of mathematics, developed by Schoenfeld (1987).

The two tables below compare responses to each of two statements, (i)*To solve mathematics problems you have to be taught the right procedure, or you can't do anything* and (ii) *In maths you can be creative and discover things by yourself.* After experiencing the approach used in Mathematics 1, we might expect students would be more likely to disagree with the first statement and agree with the second statement.

Table 3 compares the responses of the two groups of female students, those who are fluent in English and those who have little or moderate fluency in English, to the first belief statement, *To solve mathematics problems you have to be taught the right procedure, or you can't do anything.* Over 60% of females who are fluent in English disagree with this statement, but almost 80% of female students who have little or moderate fluency in English are Undecided, Agreed or Strongly Agreed with the statement.

Table 3: Responses of females at the posttest to the statement *To solve mathematics problems you have to be taught the right procedure, or you can't do anything*

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Fluent (n=13)	0%	62%	0%	38%	0%
Little or moderate fluency (n=14)	0%	21%	29%	36%	14%

The responses of the two groups of female students to two other belief statements (i) *The best way to do maths is to memorise all the formulas* and (ii) *Everything important about maths is already known by mathematicians* follow a similar pattern.

Table 4 compares the responses of the two groups of female students to the statement, *In maths you can be creative and discover things by yourself.* Over 75% of females who are fluent in English Agree or Strongly Agree with this statement, while 50% of female students who have little or moderate fluency in English respond in these categories.

Table 4: Responses of females at the posttest to the statement *In maths you can be creative and discover things by yourself*

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Fluent (n=13)	0%	8%	15%	62%	15%
Little or moderate fluency (n=14)	0%	7%	43%	43%	7%

Discussion

For students who are fluent in English, a higher proportion of females than males indicated a definite increase in mathematical confidence. Many comments about "the maths" in Mathematics 1 from females, not males, were about the relevance of the mathematics. Research indicates that women have less confidence that males as learners of mathematics and that more females than males do not usually see the usefulness of mathematics (Fennema, 1995). It seems that the realistic nature of the Mathematics 1 curriculum has impacted considerably on these perceptions of female students.

Among students who are fluent in English, the high proportion of positive responses and the high achievement of females in this paper confirm research by Vale (1993), who found that females performed better than males on investigative projects. Our results seem to challenge research findings which indicate that gender differences occur in "complex problem solving" (Campbell, 1995) and on tasks that require "functioning at high cognitive levels" (Fennema, 1995).

There is a different story for many of the students who have moderate or little fluency in English. A reasonably high proportion gave negative responses to the question about "the maths" in Mathematics 1 as well as to the question about whether Mathematics 1 affected their mathematical confidence. This result may indicate that the demands of language or contextual detail involved in the Mathematics 1 curriculum "constitutes an excessive cognitive load" (Helme, 1994:2), or possibly indicates a cultural bias in the contexts used (Lajoie, 1995). There are also differences in responses to statements concerning beliefs about the learning of mathematics between those who are fluent in English and those students who have moderate or little fluency in English. The beliefs of the latter group may be contributing to the difficulties they have in solving nonroutine problems (McLeod, 1994).

Interviews with two students who had moderate fluency in English illustrate the range of responses to Mathematics 1 from the group who had little or moderate fluency in English, although the age of these students may be a significant factor (Miller-Reilly, 1997). A Japanese female student, who had lived in NZ for 5 years and had just left high school, found studying in Mathematics 1 was *"Uncomfortable! Very!.... because I don't*

understand the maths right from the beginning". It was *"different, more writing rather than solving just the questions",* which was her experience from high school. *"You have to write why and sometimes I just don't know why".* She had liked studying maths in high school, where she completed the first three years of mathematics. She found it *"quite easy",* and said *"if you can't solve that problem then just ask the teacher....I memorised everything, all the formulas and so on."* When she was asked "If Maths 1 were a kitchen utensil, what one would it be?", she replied *"an electric element (not the oven)... electric one is so inconvenient - if busy and want hot water, it's not like gas, takes a long time to heat, and if you don't need it still hot!".* She said her high school experience *"must be a knife, because useful and everyday have to use... easy to cut, that is to solve problem, although sometimes need to sharpen it, so need to think a bit first sometimes".*

An older male student, who immigrated to NZ from South East Asia 6 years ago, where he had run a business for over 20 years, liked Mathematics 1. He regretted that he had not had a *"very good education before",* just graduating from high school. Although the tasks were quite easy for him, he enjoyed making them more challenging *"in order to understand more".* When he was asked "If Maths 1 were a kitchen utensil, what one would it be?", he replied the *"main thing, the thing you use for stir fry"* because it's the *"thing you must use".* He chose this analogy for his experience in Mathematics 1 because *"No matter what questions you solve in the future, you must use this".* For his high school experience, he said it was a *"a frying pan, so much stuff in it, so much to do and memorise".* He said that they didn't necessarily *"understand but memorise it".*

These analogies were used to help students conceptualise, and evaluate, their experience in Mathematics 1 (Sims, 1981). Further investigation of the use of analogies as a research technique to explore students' reactions is ongoing (Ocean & Miller-Reilly, 1997).

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