Attitudes towards mathematics: What about NESB students?

Catherine Pearn, La Trobe University
Christine Brew, Monash University
Gilah Leder, La Trobe University
Alan Bishop, Monash University

In this paper we draw on data from the second stage of a three year study conducted in eight Victorian, state co-educational secondary schools. In 1995, one Year 7 and one year 9 class, from each of four schools with high numbers of non-Anglo cultural background students, participated in the project. Four sources of data were collected. This paper focuses on the analysis of questionnaire responses and where possible snippets of student interviews have been included in an attempt to clarify issues raised.

Introduction

Are students from non-English speaking backgrounds [NESB] advantaged or disadvantaged in mathematics? Should we focus on newspaper reports which highlight the high achievements of some groups, often students who have come to Australia from Asian countries? Or should we concentrate on data which indicate that mathematics is often a difficult and alienating subject for students for whom English is a second language? In this paper we focus on students who may be experiencing conflicts in mathematics in terms of gender, ethnicity or class. We report on the second part of a three year study, undertaken in 1995 with students from four schools with a predominantly non-English speaking background. (In 1994 the four schools involved had high percentages of predominantly English speaking students). (See Brew, Pearn, Bishop and Leder, 1995).

Explanations and interpretations of underachievement in mathematics have tended to move away from the cognitive domain and to focus more on student attitudes (McLeod, 1992; Schoenfeld, 1992). Moreover as the social dimension (Bishop, 1985) has come to be recognised as a highly significant factor in mathematics education, so the need has arisen to carry out studies which examine the roles of particular individuals and groups in influencing students' attitudes towards mathematics and mathematics learning. In fact, "The unique culture of each mathematics classroom is the product of what the teacher and pupils bring to it in terms of knowledge, beliefs and values and how these affect the social interactions within that context" (Nickson, 1994, p. 28).

According to a report released about the study of young people's attitudes to secondary education (Dua, 1994), 31% of girls felt they were pressured to underachieve at school but only 20.9% of males believed there was such pressure on girls.

> Girls felt pressure from all quarters - not only from male students at school but also from their own peer groups and also from their parents ... There's a widespread feeling among educators that there are no longer these pressures on girls to underachieve but this survey shows that's just not the case and they are still subjected to stereotyped roles. (The Age, 12/9/94, p.5. In *Schoolgirls tell of pressure to fail*, quoting Andre Dua).

In this study we explored the perceptions and relationships involving individual students, their peers, their mathematics teacher and their parents. These were assumed to be the most significant 'others' likely to influence students' attitudes. As well as providing summary data for this cohort of mainly non-Anglo cultural background students, we include snippets of interviews which clarify student responses.

The Sample

The four 1995 schools were selected on the basis of their high percentage of NESB students (determined from data from the Victorian Department of School Education) with two schools from a low/medium socio-economic status [LSES] area and two from a

medium/high socio-economic [HSES] area. Socio-economic status was based on Census data of the school's catchment area, participation in the Disadvantaged Schools Program, and proportion of students receiving the Educational Maintenance Allowance [EMA]. Two schools were located in the North Western Region; two in the South Eastern Region of Victoria. One Year 7 and one Year 9 class from each of the four co-educational schools participated in the project. The sample comprised 188 students, 95 girls and 93 boys.

Data Sources

Data were collected from four sources. Questionnaires were administered to the students in each of the four classes studied. Each class was videotaped for a minimum of three lessons. These videos were used to observe students who were perceived by their teachers as being either successful or unsuccessful with their mathematics learning. The targeted students and, where possible, their parents were interviewed.

Questionnaires

To ascertain the students' attitudes towards mathematics, a multi-dimensional questionnaire was developed, using items from the Fennema-Sherman Attitude Scales (1976), the Mathematics Attribution Scale (Fennema, Wolleat & Pedro, 1979), the Individualised Classroom Environment Questionnaire (Fraser, 1990) and items developed by the researchers based on statements from *The National Statement* (Australian Education Council, 1991). This questionnaire was administered to all students from the sixteen classrooms participating in the project in 1994 and 1995.

The questionnaire had four distinct sections. *Your Views about Mathematics* tapped students' perceptions of mathematics. *More Views about Mathematics* assessed students' attributions for success and failure in mathematics: to ability, effort, task and environment. *How Good Are You?* determined the students' perceptions of their own ability in mathematics and how they thought their parents, teachers, and peers would rate them as learners of mathematics. The *Individualised Classroom Environment* questionnaire was used to obtain each student's perception of the learning environment within the mathematics classroom. Most items required students to respond on a five point scale from Strongly Agree to Strongly Disagree. The number of items in each section and one example from each section are shown in Table 1.

Table 1. Questionnaire items.

Questionnaire Section	Number of items	Representative Item.
Your Views about Mathematics	42	Maths is one of the most worthwhile and necessary subjects to study at school.
More Views about Mathematics	9	Imagine you have not been able to keep up with the rest of the class in maths this term. This happened because: Students sitting near you wouldn't work.
How Good Are You?	8	How good are you at maths?
Individualised Classroom Environment	50	The teacher helps each student as much as possible.

Questionnaire Results

Students' General Perceptions

Your Views About Mathematics: Students generally thought mathematics was useful, believed they were reasonably persistent in their mathematical studies, were not

particularly anxious about mathematics, felt supported by their teacher, believed mathematics was logical, did not believe mathematics was a male domain and were relatively confident about studying mathematics.

Differences emerged on the basis of students' perceived performance in mathematics. When compared with their general views about mathematics, students who rated themselves as 'low achievers' were uncertain about the usefulness of mathematics, believed themselves to be less persistent and perceived themselves to be far less confident about mathematics than other students. They were also more anxious about doing mathematics, believed they received less support from their teacher, and were less able to relate to mathematics as a logical subject. How these factors converge and are experienced by low achievers emerged in interview. Two examples follow,

I: What is it like being in your class?
E (Year 9 boy): It just gets really boring working by yourself for 50 minutes doing nothing. It gets really boring. It is the most boringest part of the day, maths is. I hate going to maths.
I: Do you ever ask your teacher for help?
E: Sometimes, when I do work.
I: What happens when you do?
E: She comes over and practically tells you the answer to the questions and doesn't help you do it.
I: Why do you think she does it like that?
E: I don't know, type of person she is, she knows it. It is difficult when you know something and try and describe it to some-one. You have to tell them the answer and then they will understand it.
I: Do you ask any friends around you for help?
E: I am not allowed to sit with my friends. I would say that I work better around friends but I don't behave as well. I work well but I don't behave. Sitting by myself I behave better but I don't work. I find it easier to work with friends, they know how to describe it to you. It is easier for a friend describing it than a teacher, and I work better around them.

A year 7 boy who believed that he was 'about average' at mathematics perceived that his teacher would rate him as 'under average' because "I always muck around. Or she always thinks I muck around". He reported that he found it difficult to get help from the teacher.

I: Do you ever ask your teacher for help?
A: No, because then she will always get angry at me.
I: Why does she get angry with you if you need help?
A: I don't know. It is just ..., she never helps me , because I asked her for help once, and she didn't. She said all this stuff and then said, 'Oh, try it yourself', which I had already done.

Classroom observations revealed this student was disruptive in class, that the teacher worked with him but he was not always receptive to her assistance. The incident described above was probably one that occurred when the teacher lost her patience but unfortunately this is the incident the student chose to remember.

How Good Are You At Maths: Students indicated overwhelmingly that they wanted to do better mathematically than they were doing (83%) and they perceived that their parents also wished them to do better (70%). The low achievers generally had lower performance aspirations. In interview, differences between perceived parental and child expectations were explored. In the example below, a low achieving Year 7 boy wanted to be rated as 5 (excellent) but perceived his parents would be pleased with a rating of 4 (very good). This may restrict the student's attempt to strive for a better performance in mathematics. It would appear that this student's perceptions have been influenced by his father.

I: What maths do you like the most?
M: Times, divide, plus and that. Arithmetic.
I: You would like to be a 5, but you think your Mum and Dad would like you to be a 4. They would like you to be better but you don't have to be excellent?
M: Dad said I want you to learn times, plus and a bit more about maths than that.

More Views about Mathematics: Students generally attributed their success in mathematics to the external factors of classroom environment and task while failure was most strongly attributed to the task. Students who perceived themselves as low achievers attributed their success to the task while students who perceived themselves as high achievers were more likely to attribute their success to their ability. Low achievers were also more likely than high achievers to attribute their failure to lack of effort and ability.

Classroom Environment: This part of the questionnaire measured students' perceptions of their classroom and included the five factors: participation, personalisation, independence, differentiation and investigation. Results indicated that although students felt they could interact with their teacher and participate in classroom activities, they did not believe they had control over decisions made about their own learning. While they indicated they were sometimes involved in tasks that developed their problem solving skills, they perceived there was a lack of provision for individual learning preferences, abilities, interest or rate of working.

The data suggest that students who perceive they are doing well in mathematics believe that students in general receive more personalised attention in the classroom. This is consistent with the results of the first part of the questionnaire in which low achievers indicated they received less support from their teacher than high achievers.

Gender Differences

Your Views About Mathematics: It was particularly interesting to find that student attitudes concerning 'Maths as Male Domain' and 'Anxiety about Maths' were similar to those found by previous studies in Victorian schools (Forgasz and Leder, 1995). While both boys and girls in general rejected the notion that mathematics is a male domain, girls rejected this idea more strongly than boys ($F_{1, 160} = 22.99$, $p<0.001$). Evidence was obtained, from both boys' and girls' interviews, of a perception that boys were naturally better at mathematics than girls. This view was rationalised at times by boys in terms of differing levels of interest portrayed by boys and girls. For example, "Basically more boys like maths than girls, and they like to be engineers." In comparison, at least one Year 9 girl suggested that girls are more creative than boys and that this has implications for how well they perform.

I: Tell me why girls have to work harder than boys at maths.
Y: Because I think that boys are naturally born with the ability. I have always felt they are more bred into that subject and girls like the creative area.

Although not statistically significant a relationship was found between students' perceived performance and their perception of mathematics as a male domain. This trend was most apparent at Year 7 where low achieving girls and boys indicated they are less convinced that mathematics is not a male domain.

Boys perceived themselves to be more confident at mathematics than girls (boys: average of 4.0, meaning they are confident and girls an average of 3.6, meaning they are more uncertain about their level of confidence, $F_{1, 163} = 12.16$, $p< 0.001$). At Year 7, this gender pattern was only evident for students who rated themselves as average.

Gender differences emerged for the perception of mathematics as a subject (Table 2). Girls believed more strongly than boys that *to learn maths you need to explain what you are doing*. This pattern was more evident at Year 7. Girls were less convinced that *mathematics made sense*. Boys were more likely to disagree with *In maths there should always be one right answer*. There was no gender difference for a similar question: *In maths it is possible to have more than one right answer*, suggesting that girls are as aware as boys that it is possible to have more than one right answer when working mathematically but are more in favour of there *being only one* right answer. This perception was illustrated in interviews. For example,

K (Year 9 girl): With problem solving it is really hard and I like working with things where they have a basis. With problem solving you have to think of everything and everyone has different ideas so it is hard to come up with a solution. And there is lots of different answers you can have, I like it when you have only one right answer.

Table 2: 'Perception of mathematics as a subject' by gender.

'Perception of mathematics as a subject' (1= strongly disagree and 5 = strongly agree)	Girls	Boys	t-Test ‡ denotes $p < 0.05$
Most of the time maths makes sense.	3.2	3.6	$t_{182} = 2.31$ ‡
To learn mathematics you need to explain what you are doing.	4.0	3.6	$t_{176} = 1.97$ ‡
*In maths there should always be one right answer.	2.8	3.3	$t_{182} = 2.39$ ‡
In maths it is possible to have more than one right answer.	3.8	3.9	-

* For this statement 1= strongly agree and 5= strongly disagree.

How Good Are You At Maths?

Self Rating: Boys were more satisfied than girls with their level of performance in mathematics (Table 3).

Table 3: Satisfaction with current performance in mathematics.

	I want to do better	I am happy with my performance	I don't want to do as well as I am.
girls	91%	8%	1%
boys	71%	29%	0%

Furthermore, boys considered themselves better at mathematics than did girls (mean for boys = 3.7; for girls = 3.3, $F_{1, 172} = 12.42$, $p < 0.001$). This pattern was consistent for perceived ratings of significant others except for peers: teachers (mean for boys = 3.6; for girls = 3.3, $F_{1,169} = 5.33$, $p < 0.05$), mothers (mean for boys = 3.9; for girls = 3.3, $F_{1, 168} = 15.8$, $p < 0.001$), and fathers (mean for boys = 3.8; for girls = 3.2, $F_{1, 158} = 14.14$, $p < 0.001$). Boys were more likely than girls to believe their peers under-rated their performance ($F_{1, 167} = 13.31$, $p < 0.001$) but the majority of boys and girls perceived no difference between self and peer rating (Table 4).

Table 4: Peer Influence.

	'Peers over-rate my performance'	'Peers equal-rate my performance'	'Peers under-rate my performance'
Girls (n = 91)	35%	55%	10%
Boys (n = 92)	14%	65%	21%
Overall (n=183)	25%	60%	15%

Our results may help to explain the findings of the National Youth Survey (Dua, 1994) which found in response to the question asked of 15-25 year olds "Do you think there are undue social pressures on girls to underachieve at secondary school?" that 26%

agreed, 59% disagreed and 15% were undecided. This survey found that females and males differed significantly in their views, with 31% of girls feeling undue pressure to underachieve but only 20.9% of males believed that there was such pressure on girls.

Classroom Environment: For boys, lower achievers perceived their classrooms to be less personalised. This pattern was not evident for the girls who, across perceived performance levels, consistently rated the personalisation of the classroom as high. These results are reflected in students' responses to levels of teacher support. Low achieving boys clearly felt less cared for by their teachers. A sense of being punished by teachers for misbehaving, also evident in earlier comments quoted from low achieving boys, probably contributed to this perception of less personalised positive attention.
I: Did you ask your teacher for help?
J: No I didn't because if I put up my hand for help he wouldn't come over to me.
I: Why do you think he didn't come over to help you?
J: I don't know, because he used to think I was a trouble maker.

Year 7 boys also perceived that classroom tasks were more differentiated than did the Year 7 girls, where differentiation relates to students' perceptions that tasks are set with an emphasis on the individual's ability, learning style, interest and rate of working. This was more evident in the classrooms of the two schools listed on the Disadvantaged Schools Program. As there was no relationship between personalisation and perceived performance levels, it is not clear how to interpret this result. Further analyses of the interview and video data may shed some light on this finding.

School Differences

The four schools were chosen based on their high percentage of NESB students with two LSES schools and two HSES schools. Differences between schools could be due to their socio-economic status, NESB enrolment or teacher-related issues. Explanations for school differences need to be explored more fully through an analysis of interviews and videotape data.

Your Views About Maths: A school difference emerged for the 'Maths as a male domain' construct and the order of means suggests that socio-economic status was a contributing factor. LSES schools had means of 3.7 and 4.0 while HSES schools had means of 4.2 and 4.3 ($F_{3, 160} = 7.02, p < 0.001$). From interview data, poor language comprehension may have been a compounding factor in this result. Two examples follow,

I: Girls are logical enough to do well at maths, you disagreed with that. What would be the reason for that?
B (Year 7 boy): I don't know what logic means.
I: Do you think that girls can think step by step?
B: Yes.
I: So you didn't understand the question.
B: Yes.

I: Girls often have to work harder than boys to do well in maths, you are unsure, why are you unsure about that?
V: 'Cause sometimes girls are better than boys and boys can be better than girls, so it is mixed, I am not sure about that.
I: It says that girls often have to work harder, do you think that they often have to work harder?
V: Yes, 'cause boys muck around more than girls.
I: So you are saying that you see girls working harder than boys?
V: Yes.

While there appears to be some problems in the interpretation of questions, the girls' average score for this construct was still higher than the boys' at both DSP schools.

This pattern was consistent across all the data. A wish not to reveal sexist beliefs in interview may have been a factor but for some boys this was not apparent. For example:

I: You have agreed that girls have to work harder than boys to do well at maths. Tell me about that experience, is that what you have noticed?
M: Some girls they get marks better than the boys but sometimes boys do, depends. They don't listen and boys, they listen all the time.

Compared to other schools, students at one school indicated they were more supported by their teachers. This particular school had implemented a proactive program aimed at improving the rapport between staff and students, for example, having a staff-student common room.

Success/Failure Attribution. Students at DSP schools were less likely to attribute their failure in mathematics to lack of effort. The attribution of success to the environment was also significantly higher for Year 7 students at DSP schools.

Classroom Environment. In one school students generally perceived their classroom to be the least personalised, the least encouraging of student participation and that they were less likely to be given investigative tasks. This class was continually changing during the time of the study. New migrant students were frequently being placed in the class and then subsequently moved to another. Some students were frequently absent. Hence the opportunity for the teacher to create a cohesive and supportive group environment and a supportive relationship with the students was continually being challenged. Interestingly, this was reflected in the students' responses on the paper-and-pencil instrument.

Students at another school felt they had the least independence. As this was consistent across both year levels it may be a school rather than a particular teacher effect. Questions in the independence scale were challenged by the staff from this school for not actually measuring student independence. Rather, the Year 9 teacher perceived it was perhaps measuring teacher control. The Year 9 teacher did take considerable care in deciding with whom students would work during group activities, and this action would have diminished the measured level of student independence in the classroom.

I: Your teacher chooses who you work with sometimes. What is that like?
K. That is alright as you don't get along with people and you have a top group of people and they always go together and other people are left out. And when the teacher chooses they get different people.

These results suggest how more detailed interview data can illuminate responses made to paper-and-pencil instruments.

Conclusion

The results obtained from the questionnaire have corroborated the findings of previous studies concerning gender differences in attitudes towards mathematics. This consistency makes us more confident about the validity of our other findings. Students' perceived performance ratings have provided new information concerning students' attitudes towards mathematics, particularly in relation to the impact of peers and parents. Further analysis of the student interview data and interviews with parents (still to be collected), may help to clarify the emerging patterns.

Because students' attitudes towards mathematics differed significantly on the basis of school, year level, gender and students' own performance level, our results have implications for the teaching of mathematics. Lower achievers perceive their classroom differently from high achievers and express considerable conflict with the subject as it is taught. For example, they attribute their failure more to the nature of the task and do not believe they have the ability to do mathematics.

Year differences revealed substantial variation in students' perceptions about the nature of mathematics classrooms. Year 7 students reported that their mathematics classrooms were more differentiated than Year 9 students. Year 7 students were found to be less anxious and more confident than Year 9 students. Year 9 students were more likely to attribute their success to the environment than were Year 7 students and the Year 9 low achievers most strongly agreed that failure was due to effort. In addition, the Year 9 students perceived mathematics to be less about following rules and obtaining one right answer. Clearly the Year 9 experience is different from the Year 7 experience for these students, and in some way the higher confidence levels for Year 7 students has not been maintained. Year 7 students also perceived their mothers and fathers would like higher performance ratings in mathematics than did Year 9 students. More detail on this apparent family influence may be revealed from our analysis of interviews with parents.

The outcomes of one school's strategy to improve teacher-student rapport were confirmed by our results. School practices that took account of the differing cultures experienced at home and at school included time allocation during school hours for homework with special support from peers, older students and teachers. Students at this school felt more supported by teachers and felt their classrooms were more personalised. The importance of a caring and supportive school environment, especially for students from other cultural backgrounds, needs further investigation.

The issues for NESB students appear to confirm what we know about students in general and their attitudes to mathematics. Further analysis will involve a comparison of the 1995 schools with their 1994 counterparts to investigate the compounding variables that apply to these special groups.

References

Australian Education Council (1991). *A National Statement on Mathematics for Australian Schools.* Carlton: Curriculum Corporation.

Bishop, A. J. (1985). The Social Dimension of Mathematics Education, Keynote address to the American Educational Research Association Special Interest Group on Research in Mathematics Education pre-session, National Council of Teachers of Mathematics conference, San Antonio, USA.

Brew, C., Pearn, C., Bishop, A. & Leder, G. (1995). *The mathematics of success: Beyond questionnaires.* Paper presented at Australian Association for Research in Education conference. Hobart.

Dua, A. (1994). *National Youth Survey: Secondary Education.* Sydney. Australian Youth Institute.

Fennema, E & Sherman, J. (1976). *Fennema-Sherman Mathematics Attitude Scales.* JSAS: Catalogue of Selected Documents in Psychology, 6(1), 31. (Ms No.1225)

Fennema, E., Wolleat, P., & Pedro, J. D. (1979). *Mathematics Attribution Scale.* JSAS: Catalogue of Selected Documents in Psychology, 9(5), 26. (Ms. No. 1837).

Forgasz, H. J. & Leder, G. C. (1995). Single-sex mathematics classes: Who benefits? *Nordic Studies in Mathematics Education.* Sweden: Kompendiet, Goteberg.

Fraser, B. J. (1990). *Individualised Classroom Environment Questionnaire: Handbook.* Hawthorn, Victoria. Australian Council for Educational Research.

McLeod, D. B. (1992). Research on affect in mathematics education: a reconceptualisation. In D. Grouws (Ed.) *Handbook of Research on Mathematics Teaching and Learning: A Project of the National Council of Teachers of Mathematics* (pp. 575-596). New York: Macmillan.

Nickson, M. (1994). The culture of the mathematics classroom: An unknown quantity? In S. Lerman (Ed.), *Cultural Perspectives on the Mathematics Classroom.* (pp. 7-36). The Netherlands: Kluwer.

Schoenfeld, A. H. (1992). Learning to think mathematically: problem solving, metacognition, and sense making in mathematics. In D. Grouws (Ed.) *Handbook of Research on Mathematics Teaching and Learning: A Project of the National Council of Teachers of Mathematics* (pp. 334-370). New York: Macmillan.