

AFFECTIVE BELIEFS AND RELATED BEHAVIOURS IN THE MATHEMATICS CLASSROOM: A CASE STUDY OF A GROUP OF FOUR STUDENTS

Helen J. Forgasz
Monash University

Abstract

Affective variables are included in several models explaining gender differences in mathematics learning. Not much is known about the relationship between students' beliefs and the context in which they learn mathematics. This study aimed to infer attitudes from behaviours in the classroom, to compare these with attitudes determined from more conventional pen-and-paper measures, and to examine learning context factors which might explain inconsistencies and contribute to our understanding of gender differences in mathematics learning. Two male and two female grade 7 students, who sat together, were observed for fourteen consecutive mathematics lessons which were videotaped. During the monitored period, the students were engaged in individual and paired tasks and one collaborative project. Analyses revealed that students' behaviours were fairly consistent with their beliefs. Relevant contextual factors which might account for the consistencies and the differences found among and between the students included group composition, the content and demands of the mathematical tasks, and the teacher.

INTRODUCTION

Gender differences in mathematics learning outcomes continue to attract research attention. Affective variables have been included in several models explaining gender differences in mathematics learning. The Autonomous Learning Behaviors [ALB] model, postulated by Fennema and Peterson (1985) has particular relevance to mathematics classrooms. It suggests that societal influences, including teachers and classrooms, and personal belief systems preclude females from participating in mathematics learning activities and from becoming independent learners of the subject (Fennema, 1993). Fennema (1993) claimed that independence in mathematical thinking can be fostered in cooperative learning settings.

Mathematics classroom environments have generally been found to be more favourable in promoting boys' learning. Competitive activities are more prevalent than cooperative ones (Fennema, 1993) and subtle differences in teachers' treatment of students favouring males have been found (Leder, 1992). Fennema (1993) maintained, however, that:

Identifying behaviors in classrooms that influence gender differences in learning and patterns in how students elect to study mathematics has been difficult. (Fennema, 1993, p.7)

In studying the relationship between mathematics learning outcomes and attitudes and beliefs, the context of learning and the evaluation of overt behaviours are frequently omitted. Pen-and-paper

instruments and interviews are the most common forms for measuring attitudes and process-product techniques have dominated research on classrooms. In recent times, there have been calls for more qualitative research to supplement the substantial body of knowledge derived mainly from quantitative studies (Good, Mulryan, & McCaslin, 1992; Leder, 1992; McLeod, 1992).

PARTICIPANTS

Two male (R and S) and two female (C and J) students from one grade 7 mathematics class in a government secondary college in metropolitan Melbourne were the participants in the study. The male teacher (TD) was experienced and taught mathematics across the secondary grade levels.

AIMS AND METHODS

Within the framework of the ALB-model, the study aimed to infer students' attitudes towards mathematics and towards themselves as learners of the subject from behaviours in the mathematics classroom, to compare these attitudes with beliefs derived from more conventional pen-and-paper measures, and to examine learning context factors which might account for the findings and contribute to our understanding of gender differences in mathematics learning.

The research methods adopted were similar to those reported by Leder and Forgasz (1992). The variables of interest were derived from the ALB-model. Conventional pen-and-paper instruments were used. Students responded to items in closed and open-ended formats. The variables included students' perceptions of: mathematics as a male domain, teacher support, persistence, confidence, usefulness of mathematics; students' attributions of success and failure in mathematics to ability, effort, task and environment; and their beliefs about mathematics achievement and the ratings of achievement which significant others would assign to them. Sample items from a selection of the subscales are shown in Table 1.

Table 1: Examples of variables and sample items from pen-and-paper instruments

Variable	Sample item
AFFECTIVE VARIABLES	
Maths as a Male Domain	Girls often have to work harder than males to do well at maths (negatively worded)
Persistence	When I make a mistake in maths I try to work out where I went wrong before asking for help
SUCCESS ATTRIBUTIONS	
Ability	<u>Item stem:</u> You got the results you wanted for the term in maths You are good at maths
FAILURE ATTRIBUTIONS	
Effort	<u>Item stem:</u> You have not been able to keep up with the rest of the class in maths this term: You haven't spent much time working on maths
MATHEMATICS ACHIEVEMENT	
Self-rating (HGM)	How good are you at mathematics?
Believed teacher's rating (TGM)	Where would you teacher put you on this scale?

Each item was scored on a five-point Likert-type scale. Open-ended items included: Do you like maths? Explain; Do you think women or men are better at maths? Explain. Students indicated their feelings after each lesson on 'Today's lesson' sheets and interviews were conducted at the end of the lesson monitoring period.

The teacher was asked to rate the students' mathematics achievement on a 5-point scale (1=weak to 5=excellent) and two measures of mathematics achievement were obtained. Students completed the PATMATHS Test 2A (ACER, 1984) and the teacher prepared and scored an end-of-topic test based on the work covered during the period of classroom observations.

Fourteen sequential mathematics lessons were observed over a one month period (July/August, 1993) and were videotaped. The topic, selected by the teacher, for the period of observation was 'Chance and data'. Operational definitions of relevant ALB-related affective behaviours were developed; several have been described elsewhere (see Leder & Forgasz, 1992). The first two lessons in the sequence were designed to familiarise students with the camera's presence and to provide baseline information about the more general conduct of TD's lessons.

RESULTS

Figures 1 - 3 show the scores for each of the four students and class mean scores for the affective variables and the success and failure attribution subscales.

Space constraints limit the findings which can be discussed in this paper. Selected results which will complement the observational data are summarised below. From Figure 1 it can be seen that:

- * the females (C and J) were less stereotyped about mathematics as a male domain than were the males (high scores indicate less stereotyping); S was the most stereotyped of the four students; his score (22.00) was considerably lower than the class mean ($\bar{x}=28.00$, $sd=2.13$)
- * C and J considered themselves more persistent at mathematical tasks than did the males. R regarded himself to be less persistent at mathematical tasks than did the others. His score (20.00) was well below the class mean ($\bar{x}=22.86$, $sd=3.56$)
- * C was lowest and J was highest in confidence as learners of mathematics. J's score (30.00) was considerably higher than the class mean ($\bar{x}=22.58$, $sd=5.76$).

The following are the noteworthy results derived from Figure 2:

- * the males (R and S) scored higher on attributing success to ability than did the females.
- * overall, the females scored higher on attributing success to effort than did the males (NB. J and S scored equally).
- * the females considered effort most important for success (for C, the environment was equally important); for R, ability and task were equally the most important
- * the females viewed ability as least important for success; R considered effort least important

Figure 3 indicates that:

- * the two males (R and S) scored higher on attributing failure to lack of ability than did the two females
- * the two males scored higher than the two females on attributing failure to lack of effort. Of the

- two males, S scored much higher than R
- * C, J and R considered task difficulty the most likely cause for failure; for S it was lack of effort
- * the two males scored higher than the two females on attributing failure to the environment. Of the two males, S scored much higher than R

On Figure 4 are shown the results of the students' believed achievement ratings, the teacher's rating of the student's achievements, and the scores on the two measures of achievement: the end-of-topic test and the PATMATHS. The scores on the achievement measures were converted to scores out of 5 for comparative purposes only. Figure 4 reveals that:

- * J and R considered themselves equally good at maths (HGM). Their scores were higher than those of C and S who also assigned themselves the same achievement levels
- * J and R were rated by the teacher to be excellent at mathematics; C and S were regarded as satisfactory and about average for the grade level
- * J and R underestimated and S overestimated their teacher's rating of their achievement levels
- * J scored highest on the end-of-topic test with C and R scoring equally. With the exception of S, the students' scored above the class mean
- * the females (C and J) scored higher than the males on the PATMATHS

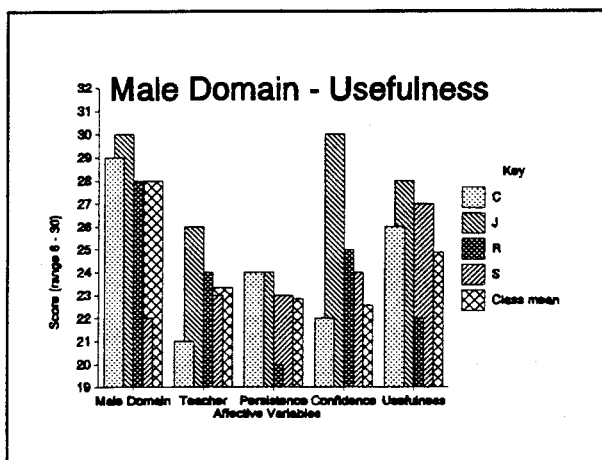


Figure 1. Students' scores on the affective variables Male Domain to Usefulness and class mean scores

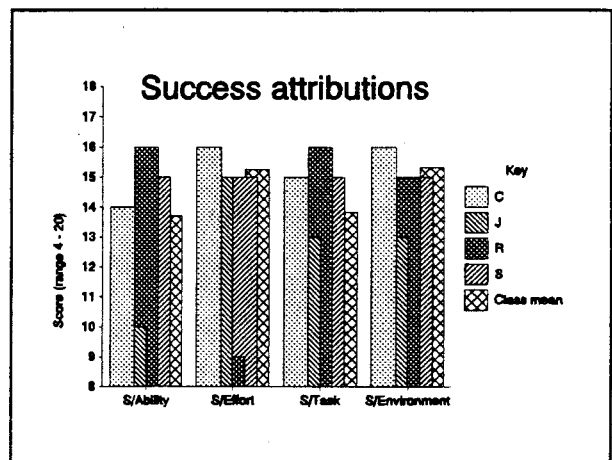


Figure 2. Students' scores on the success attributions subscales and class mean scores

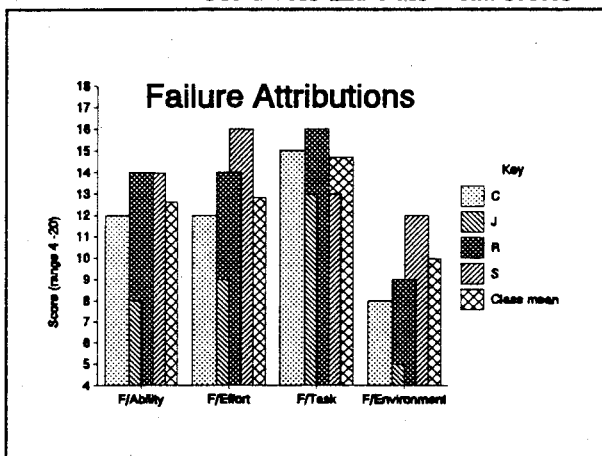


Figure 3. Students' scores on the failure attributions subscales and class mean scores

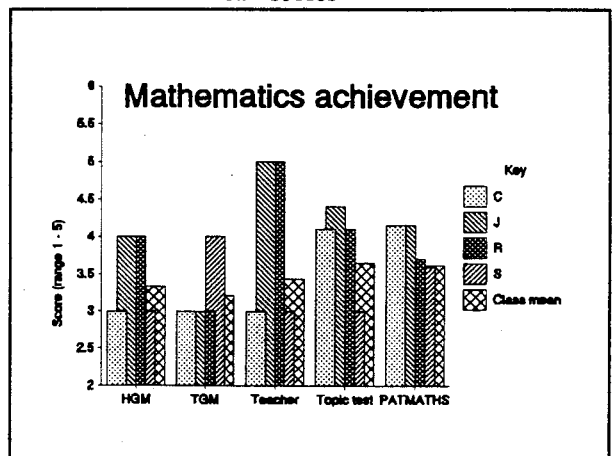


Figure 4. Self-ratings of mathematics achievement, believed teacher's ratings, actual teacher ratings, scores on two achievement measures and class mean scores

A brief overview of lessons 4 to 7 in the series of lessons videotaped is given in Table 2. It was during these lessons that the students worked on the collaborative 'Scrabble Project'. Students were required to compare the frequency of letter usage in the English language with the frequency of letters used in the game of Scrabble. Assessment for the project was to be based on the group's report recorded on a single cardboard poster sheet.

PLACE TABLE 2 HERE

On Table 3 critical incidents, verbal exchanges and students' ALB-related behaviours from lesson 7 are recorded. The behaviours described were not restricted to lesson 7. Space constraints, however, restrict the discussion to episodes from this lesson.

PLACE TABLE 3 HERE

DISCUSSION AND CONCLUSIONS

While there were some discrepancies, there was fair consistency in the students' beliefs about themselves as learners of mathematics and their classroom behaviours. During verbal exchanges both R and S used gender-stereotyped (sexist) language. Their disruptive behaviour in the classroom followed patterns considered more characteristic of boys than of girls. It was also found that the boys were more stereotyped about mathematics as a male domain than were the girls.

During the 'Scrabble' project, J and C did the bulk of the work. Both boys scored lower than the girls on beliefs about persistence at mathematical tasks. Classroom behaviours confirmed these differences. The girls persisted doggedly in their attempts to complete the task and to obtain cooperation from the boys. R was constantly complaining that he did not understand what was going on. This was interpreted as a (successful) work avoidance tactic. Showing no apparent preparedness to think for himself, he successfully attracted more personal teacher time than the others, yet did very little. The girls expressed their frustrations at the boys' 'lack of effort' but to no avail. They raised the issue on several occasions with the boys and with TD. In return the boys were offensive and insulting. TD's actions were not directly supportive of the girls. He reminded the boys that group assessment applied to the project but did not admonish them. The boys' work avoidance tactics appeared to pay off. The added bonus was the prospect of achieving the same grade as the girls. J believed TD was more supportive of her as a learner of mathematics than did the others. Her complaints to TD at the end of lesson 7 about the boys' negligible contributions to the project imply an expectation of support and appear consistent with her beliefs.

The boys were not interested in the 'Scrabble' project, made it clear that they did not like it, were unprepared to work effectively at it, and were inconsiderate of the girls. On the 'Today's lesson' sheets the girls indicated that they had found the project boring; nonetheless they did what was required. At interview the girls expressed their anger at the boys' behaviour. J said:

C and I got really angry, because we did the whole project. And the boys just sat there expecting us to do all the work, and we did. But we didn't really have a choice, otherwise if we didn't do it, it wouldn't get done.

While S said that everyone had contributed equally to the project, R said:

the girls probably did a bit more, but... we got the project done and... I don't know what mark we got for it, but I think it was ... pretty good.

The classroom observations and the interview data enabled some sense to be made of the differences in the students' scores on the subscales illustrated in Figures 2-4. For example, when the scores for the end-of-topic test are considered, R's relatively low score for success attributed to effort and the girls lower scores for attributing failure to lack of effort have a contextual basis.

Observations during the 'Scrabble' project challenge notions that this form of group work would enhance C and J's mathematics learning outcomes, particularly in the affective domain. When adopting group work as an instructional strategy, group composition, and the nature and demands of the task would appear to be critical factors to be considered. Before engaging in group work, some students may need to learn the relevant interpersonal skills of respect and cooperation.

REFERENCES

- Australian Council for Educational Research [ACER] (1984). PATMATHS: Progressive achievement tests in mathematics. Teachers handbook. Hawthorn, Victoria: Author.
- Fennema, E. (1993, October). Mathematics, gender, and research. Paper presented at the International Commission on Mathematics Instruction Conference: Gender and mathematics education. Höör, Sweden.
- Fennema, E., & Peterson, P. (1985). Autonomous learning behavior: A possible explanation of gender-related differences in mathematics. In L. C. Wilkinson & C. B. Marrett (Eds.), Gender related differences in classroom interaction (pp.17-35). New York: Academic Press.
- Good, T. L., Mulryan, C., & McCaslin, M. (1992). Grouping for instruction in mathematics: A call for programmatic research on small group processes. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning, pp.165-196. New York: Macmillan Publishing Company.
- Leder, G. C. (1992). Mathematics and gender: Changing perspectives. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp.597-622). New York: Macmillan Publishing Company.
- Leder, G. C., & Forgasz, H. J. (1992, November). Inside the mathematics classroom. Paper presented at the 2nd AARE/NZARE Joint Conference, Deakin University, Geelong.
- McLeod, D.B. (1992) Research on affect in mathematics education: A reconceptualization. In D.A. Grouws (Ed.) Handbook of research on mathematics teaching and learning (pp. 575-596). New York: MacMillan Publishing Company.

Table 2: Summary of the four lessons in which students worked on the Scrabble project

Lesson	Lesson summary
4	<p>Class was divided in half today. While one group was in the mathematics class, the other half was at a keyboarding class. Halfway through the period the groups swapped. TD had pre-arranged membership of the small groups to work on the Scrabble project! He outlined details of the project. The observed group took some time to decide how to gather the necessary data. J showed leadership in trying to get the group started and keep them on task. Early on R claimed: "I don't get this. I don't want to do this" - details were patiently repeated by TD. R was generally negative and uncooperative and seemed to stall the group's progress. Some of S's comments reflected stereotyped and possibly racist attitudes. The animosity between S and C carried over from the previous day. At the end of the half lesson, J tried to ensure that in the next lesson the group could continue where it had left off. Very little enthusiasm for the project was apparent among group members.</p>
5	<p>R's lack of interest in the project was revealed early: "When is this stupid project going to be finished?"; "I can't be bothered doing this". These comments were indicative of R's behaviour to follow. He frequently excused his inactivity claiming that he did not understand or did not know what was required. Patiently things were explained to him after which he rarely did anything constructive. S followed R's lead but was not as overtly negative. J and C tried to allocate tasks among group members but found their efforts thwarted. They took on many of the jobs themselves. TD did not appear to pick up on the girls' frustrations. Work began on gathering letter frequencies from 20 lines of English text. The boys participated (R reluctantly) in completing this task but made an attempt to reduce the number of lines of text to be analysed. It was unclear whether the students appreciated the mathematical rationale for what they were doing. TD suggested that the boys might begin answering the set of questions related to the letter frequency data while the girls worked on the poster sheet. Throughout, the boys adopted tactics to avoid doing any task they did not want to do. The girls grew increasingly aggravated by this behaviour and their frustration and anger were evident. At the end of the lesson C felt "we haven't done anything yet".</p>
6	<p>Work done on loose sheets of paper by the girls at home were pasted on to the poster sheet. The girls delegated tasks to group members. The boys were designated Q5, the girls would do Q6 and all would then confer for Q7. The boys' task was one of the more demanding of the entire project. Looking at line plots, produced by the girls, comparisons between the letter frequencies from their text analysis and in Scrabble were required. R made it very clear that he had no interest in the project and was going to do as little as he could get away with. He was deliberately provocative when he sang a smutty, sexist song, and nasty when he made personal jibes. He was totally uncooperative. Throughout, S followed R's lead and seemed to enjoy the 'game'. S did very little work. Unlike R whose tactics for work avoidance were deliberate and spiteful, S's were aggravating and cheeky. The girls were angry and frustrated. Their complaints to TD were met with minimal support. TD focussed on R. When R claimed that he didn't understand or know what to do (a now familiar ploy to attempt to conceal his work avoidance) TD patiently explained. There were signs that TD may have picked up on the tension within the group but his actions were ineffective. R and S were uncooperative, and the girls ended up doing most of the work. C and J worked collaboratively and persisted at trying to involve the boys. With limited support from TD they failed. Their concern to complete the project appeared to take precedence.</p>
7	<p>Class split into halves again today. This was the last class lesson spent on the Scrabble project. The girls' persisted in their attempts to get the boys to do Q5. S had left his work from the previous day in his locker. This added to the girls' frustrations and prompted C to call him "you stupid person!". Work avoidance tactics were again adopted by both boys. For example, in TD's presence R attributed the girls with "making silly accusations" about them not having done anything; he complained to the girls of "a tired brain". Again S joined R in the work avoidance 'conspiracy'. R and S were also often engaged in horseplay - hitting and shoving each other, and throwing small items across the room. They did nothing during the lesson; the girls completed the tasks they had allocated for themselves. J stayed back after the others had left the room and complained to TD that the boys' had not contributed to the project, and that neither of them would take the sheets home to finish the one question they had been asked to do. From TD's reactions, he appeared less than fully sympathetic to her dilemma.</p>

Table 3: Critical episode times, main activities and ALB-related behaviours during Lesson 7

Time	Main activities	Group members' contributions and ALB-related/affective behaviours
5.11 - 6.48	C and J discuss the border for the poster sheet - R and S fool around. At 5.27 S provokingly complains "This is really very unfair on us" - C bites and retorts "Are you being worked too hard?". S nods. C: "Gee, we did bloomin' everything". S and R do nothing. At 6.36: R: Hey, your royal highnesses! (referring to C and J) S: Royals! R: ... - they're being bitchy (to someone off camera)	C: indirectly then clearly implies S's <i>lack of effort</i> S: provocative comments suggestive of 'blame the victim' - <i>gender-stereotyped behaviour</i> . Follows R's lead in derisive labelling of C and J R: derogatory comments with <i>stereotyped overtones</i>
6.48 - 7.55	J: (to someone off-camera) Do you reckon we're unfair just because we've done 5 out of 7 questions? R: Yes, we've been worked too hard C: Worked too hard? My foot! J: They haven't done one question yet! ...Come on, we're waiting for a rough copy R: I'm doing the good copy, stuff the rough copy. I'm doing, we're doing Q5 OUR way! J: It's got to be on here. You're not doing it on lined paper R: Yes, we are C: No, do it on that paper, this paper R: No... Do you want the writing to go down like that? (gesticulates over-exaggerated down-hill slope) C: Rule, um, rule lines. Ever heard of that? R: We're doing Q5 our way! J: We can rule them, you just write on them S: We'll tell you what to write, and you write it on J: No	J: defensive, seeks confirmation of her interpretation of S and R's <i>lack of effort</i> . <i>Persistent</i> in seeking some input from R and S C: directly expresses her belief that S and R have not pulled their weight. <i>Persistent</i> in rejection of S's suggestion that she and J should do more R: deliberately provocative and <i>dysfunctional persistence</i> indicative of <i>lack of cooperation</i> . Seeking shortcuts implies <i>work avoidance</i> and <i>lack of interest/respect</i> for project. S: clear attempt at <i>work avoidance</i>
17.17 - 22.38	At 17.22, J: (to R) R, is that going to be finished? At 17.38, R asks what colour C and J want him to use. In a sing-song derogatory tone he adds: "Do I have to do it all pretty?". The girls work on the poster sheet, S does nothing, and R begins to throw things at a boy on the table behind. At 22.17, J again notices that R is not working and says: "Finished yet?". S and R give appearance of working.	J: <i>task orientation</i> and <i>persistence</i> re R's contribution to project (x2). R: comment on presentation suggestive of <i>gender-stereotyping</i> . More <i>work avoidance</i> . <i>Stereotyped</i> misbehaviour S: <i>Stereotyped</i> disruptive behaviour. C: <i>task-oriented</i>
28.09 - 29.02	J waits behind wanting to speak to TD. When he finishes speaking to another student he turns to J: J: (sighing) That's not going to fit in. TD: What's not going to fit in? C: He [R] didn't want to write it straight on there [pointing to project sheet] so he did it on this [sheet of paper] TD: Right. C: And it doesn't fit TD: Uh, it can be trimmed. J: No, but even without the little thing on the side. TD: Well, can we trim that like that.. or.. J: Haven't finished. TD: Or, maybe cut his columns out. J: But we haven't finished yet though. It's not fair. Because we're the, we did everything, and they just sat there and waited for us to do it. TD: Well, like I said, well, we'll, we'll split the assessment up into two, but you've still got to organise to get that finished. J: Yes I know. We'll end up doing the whole thing. TD: Well, did you organise with them today, who was going to finish this? J: Well, R said um, he didn't want to, and S said he didn't want to, so nobody's doing it. TD: All right, well you might have to talk about that again on Monday then. J: OK TD: Thanks Jenny. J leaves the room	J: <i>dependent behaviour</i> - unlike with R, however, TD does not appear to respond appropriately. TD: switches focus from J's main concern about inequitable input into project from S and R to the pragmatics of 'trimming the sheet'. Appears to land J with the responsibility for the failure to complete the project through lack of organisational skill (<i>lack of ability to direct situation</i>). His responses could be interpreted as condoning the boys' <i>lack of effort</i> , <i>lack of cooperation</i> and shifting the blame on J. Certainly there was no condemnation of the boys' behaviour or undertaking on his part to intervene on J's behalf. TD appeared unconcerned that J and C may themselves have to oversee the task's completion. His comment about changing the assessment into two was unclear - J did not seem to consider this of importance. Has TD implied greater importance on the <i>competitive</i> outcomes than on the <i>collaborative</i> inputs?