TAFE STUDENTS: THE AFFECTIVE DOMAIN AND MATHEMATICS

Gail E. FitzSimons

Swinburne University of Technology

According to McLeod (1992) affect plays a significant role in mathematics learning and instruction. Studies by Wood & Smith (1993) and Crawford, Gordon, Nicholas & Prosser (1993) have examined attitudes towards mathematics held by first year university students enrolled in mathematics and engineering courses. Students entering TAFE Associate Diploma courses in Applied Science are likely to differ from those entering university for two reasons:

1. Their intention may be to enrol in a vocational course in order to obtain employment in the areas of laboratory technology or fire technology.

2. They may have obtained lower tertiary entrance scores than those entering university, but may nevertheless aspire eventually to enter university through the articulation process.

This study will examine the beliefs, attitudes, and emotions towards mathematics of TAFE students enrolled in the Associate Diploma of Applied Science at Swinburne University of Technology (TAFE Division). A broad questionnaire will be administered and the results analysed.

Although affective issues are of central concern to teachers and students in mathematics education, research in this area is peripheral (McLeod, 1992), particularly in the Australian TAFE sector. TAFE students are typically among the weaker students to complete secondary mathematics subjects or have been out of school for at least one year, and possibly several. Having enrolled in a vocational course students are often surprised to find that they are obliged to study mathematics subjects once more. The mathematics subjects are known by a variety of names in the TAFE system, but are generally regarded as service subjects to support the study of other subjects. Just as mathematical ability levels are generally heterogeneous, so are the affective responses of students to mathematical issues. Recognition of the significant role played by affect in mathematics teaching and learning has prompted this attempt to document beliefs, attitudes and emotions at an inner metropolitan TAFE college in Melbourne. While Leder (1993) notes that there is an apparent overlap between attitudes, beliefs and emotions, as reflected in response consistency, this survey attempts to separate the three in order to gain more insight into students' affective domain.

Method of research

A survey questionnaire on student affective responses was administered to approximately 75 students enrolled in the Associate Diploma of Applied Science at Swinburne University of Technology (TAFE Division). It consisted of eight open-ended questions in three sections (beliefs, attitudes, and emotions) after McLeod (1992, p.578) designed to elicit students' affective responses. The section on beliefs included questions about mathematics, self-concept, mathematics teaching, and about learning mathematics. Attitudes were examined through questions on likes, enjoyment and preferences. Emotions were examined through questions on feelings elicited when doing mathematics.

The questionnaires were intentionally kept as brief as possible to accommodate the low reading/comprehension and tolerance levels of some students, and were administered by the writer at the first lesson. A qualitative analysis of the data determined the categories of response, and it was decided to include selections from student responses to give a more complete picture of the findings.

Results

Beliefs about Mathematics

The first stem: *Mathematics is about ...* elicited responses able to be categorised in a manner similar to those documented by Crawford, Gordon, Nicholas & Prosser (1993). Of 73 responses 41 (56%) indicated that they considered mathematics to be comprised of numbers, rules and formulae. Of these 41 responses about half (19) were continuing (exit-VCE) students, and 22 were classified as return-to-study students. A further 30 (41%) responses made reference to the application of mathematics to solving problems, but here the breakdown was 23 continuing students to 7 return-to-study students. Finally 2 return-to-study students (3%) gave an indication of beliefs about mathematics as a way of thinking.

Self-concept. Self-concept was explored through the second stem: *I am able/not able to ...* 36 students expressed positive ideas of self-concept in relation to "doing" certain topics; 6 considered they were able to do advanced mathematics topics, 15 said they were able to do mathematics at a general level, and 15 said they were able to do at least basic mathematics. Of the 32 negative responses 24 considered themselves not able to do advanced mathematics, while 3 responded that they were not able to do mathematics in general.

Other comments related to how the students perceived themselves as learners of mathematics. Positive comments (19) included: "being able to understand/learn quickly," "follow and use prescribed formulae," "work through problems," "be successful after application to work," "study until understanding comes." Negative comments (21) included: "being slow to learn or grasp new problems," and being unable to: "remember much," "put knowledge down on paper," "work alone," "put theory into practice," or "study mathematics adequately."

Mathematics teaching is ... 9 students thought that mathematics teaching was a difficult job to do, while 12 perceived the question from a student's viewpoint, and thought that it was difficult to be taught: that is to say, students found it hard to understand (9) or thought it went too fast (3). 7 students regarded it as being boring! A different interpretation of the question led 16 students to note that mathematics teaching was a matter of showing students the correct way to do things, with 3 mentioning clear explanations and 1 the need for constant revision. 8 students noted that teaching could be inspiring, interesting, or applied to real life. 8 commented that the teacher should be ready to help. Other comments included that the teacher should be able to associate with all the class, and enjoy the lessons. Mathematics teaching was seen variously by different students as important, essential, intended to broaden students' mathematical knowledge, and to deepen understanding.

Learning mathematics is ... Learning mathematics was perceived by 23 students as fun, easy, good, or enjoyable (for at least some of the time). It was seen as hard, boring or daunting in varying degrees by 32 students. Possibly because of the long years spent as learners, students contributed more comments in this section. They described learning mathematics as being used to solve problems, something necessary for some courses or preparation for the future, not always relevant to daily life, "a necessary evil." Other students described how mathematics is learned, qualifying earlier comments on its difficulty: " a lot of the time a constant struggle to stay on top of the workload, and to stay in touch with new topics," "OK if you listen," "can vary in complexity, can be learned with patience and hard work," "listening and doing your own problems many times over so as to understand the many different concepts," "interesting because of the realisation of how it can be applied in everyday life by using different techniques that can solve problems etc.," "fun sometimes, yet some topics (e.g. algebra) may appear boring if not introduced right," "fairly easy, but it

somehow gets harder for me to put what I learned in class on an exam," "understanding those concepts and being able to demonstrate that understanding," and "difficult at times but when it clicks it feels great. It is about understanding and remembering."

Attitudes

The responses to the stems on attitude: *I like/dislike ..., I enjoy/don't enjoy ...,* and *I prefer/prefer not to ...* were combined to gain a more complete overview of student perceptions. Students responded in terms of attitude towards mathematics overall, various mathematical topics, task type or relevance, assessment, teaching styles and learning styles.

19 students said that they had positive attitudes towards mathematics, although most qualified the statement with references to what they would prefer for themselves as learners or in terms of teacher management. 14 students said that their attitude towards mathematics was negative, with fewer qualifying statements, and these were mainly that they were not good at it. 42 students listed topics about which they felt positive, with 25 listing topics they felt negative about. Popular topics were basic arithmetic skills and trigonometry (10 responses each), algebra (6 responses), graphs/functions (5 responses), problem solving, and using the calculator (4 responses each). The least popular topics were: algebra/equations (8 responses), exponential and logarithmic functions (6 responses) and trigonometry (4 responses).

13 students mentioned positive attitudes towards understanding and/or completion of tasks: "finishing the problem, getting it right, to know what I'm doing." 7 responses were positive towards tasks relevant to daily life: "when it's related to real life situations," 6 students responded positively to tasks that were relatively easy or short: "problems, equations etc. with a regular pattern of working" whereas 3 enjoyed problems that were more of a challenge. One student commented that she liked mathematics a lot "because it challenges me and I enjoy that in a subject."

The following statements were qualifiers to statements of positive attitudes towards mathematics. From a teacher management perspective: "to know what we are doing ahead of time," "if it's not rushed and things skipped because we are slightly behind," 4 students mentioned their preference for being able to take their time, to learn at their own pace: "having time, perhaps at home, to really think and get something in my head." Others preferred to get on with work in class: "when I am actually doing something in class," or else "to go through the work in class," Yet another preferred "intensive 1:1 teaching," and

another "well-described steps when explaining formulas." . 2 students nominated assignments or projects as the preferred method of assessment, and 5 students mentioned a preference for working in groups.

Task complexity, in terms of time spent and lack of understanding was mentioned by 16 students as contributing to a negative attitude: "when something gets too difficult, I'm not good at, I have trouble in maths as it seems to get me uptight when I don't understand," "I don't enjoy spending the entire period on the same half of a topic." Negative attitudes were reported towards assessment, with 11 responses mentioning tests or exams, or fear of failing as causes. Lack of relevance was mentioned in 4 responses.

The following statements were qualifiers to statements of negative attitude towards mathematics, where teachers may have some control: not wanting to "answer things in front of other students," "doing the same thing over again when I already know how to do it," not wanting to "be interrupted when I am in the middle of a problem," "the fact that I felt left out of the 'maths circle' at school," "teachers that assume a lot of mathematical knowledge and neglect to focus on the not so talented students (bad experience)," 6 responses mentioned being rushed as a cause of negative attitude: wanting "not to have formulas and their reasoning skimmed over lightly.". Students also qualified their negative responses as learners: "not being able to solve a simple equation," "to leave problems drag on and fall behind in the subject," "not knowing what to do or why, not knowing why it's wrong, or even why it's right."

Emotions

The stems on emotion ran: *Sometimes I feel ... because ... , and sometimes I feel ... because ...* There were 30 positive responses, using the following expressions: "good" (9 responses), "quite good," "really good," "happy," "great," "confident," "pleased," "satisfied," "very excited," "OK," "motivated," "alright," "fantastic," "interested," "wanting to do more," "proud," "glad," "in control of it, and good about myself" and "possibly relieved." Most of the statements were qualified by phrases similar to the reason given by one student "because I was able to understand or work out a problem." One student expressed relief "because I am able to do it correctly (this is important as I'm very insecure about my maths ability)."

Negative responses outnumbered the positives by three to one. The most common expression used was "frustrated" (14 responses), mainly due to lack of understanding or inability to solve a problem. "Confused" (10 responses) applied to lack of understanding,

forgetting or getting lost, also "stressed (out) (6 responses). "Bored" (9 responses) applied mainly to repetition of explanation or work set. "Angry" was used 8 times, was used in a similar manner to "frustrated," but also once in relation to "making a simple error in a long problem." Other expressions used were: "lost," "afraid," "scared," "stupid," "intimidated," "isolated," "low," "tired," "left behind," "panicky," "nervous," "annoyed," "inferior," "awkward," "embarrassed," "muddled up," "anxious," "dumb," "worried," "incapable," "disappointed," "helpless," "aggravated," "depressed," "upset," "sick about doing tests," "funny and go blank," "like I don't really need some of it," "like I'm never going to understand," "like not doing maths," "unhappy with myself," and "that it is of no use in life." Besides inability to understand, and test anxiety, these comments also related to shyness, "I find it very hard and am shy to ask questions," isolation, "everyone knows what they are doing except me," and despair, "it's like a never-ending story of figures, formulas etc."

Discussion of Results

There are two issues that need to be addressed. The first is that the researcher was the future teacher of the students, and that this may have caused some bias in the results. The students were given assurances that their responses would not affect their relationship with their teacher, nor their results, in any detrimental way, and it is the author's belief that they have been given sincerely and honestly. The second is that the open-ended questions were ambiguous in some cases, and this has been documented above. The purpose of having such open questions was not to constrain the responses in any way, but it may have been better to add the word "about" to the questions "Teaching mathematics is ..." and "Learning mathematics is ..."

It is also interesting to note that in general responses from males were just as expressive as those from females.

Beliefs. The beliefs about mathematics contrasted with those of tertiary students in the survey by Crawford *et al.* (1993). The conception of mathematics as numbers, rules and formulae was held by 56% of TAFE students, compared to 26% of tertiary students, while the additional conception of application to problems was held by 41% of TAFE students, compared to 51% of tertiary students. 3% of TAFE responses compared to 13% of tertiary responses conceived of mathematics as a way of thinking. No higher TAFE response was given to compare with a further 10% of tertiary responses. These results suggest a

quantitatively different conception of mathematics held by the two cohorts. It is also interesting to note that students who had completed VCE Mathematics in its original study design (VCAB, 1990) had significantly deeper conceptions of mathematics as being applied to solve problems than the return-to-study students.

Self-concept seemed evenly balanced between positive and negative responses, but the number of responses relating to lack of ability to cope with advanced mathematics was surprisingly high, given that students have mostly completed year 12, or at least year 11 mathematics. Student comments also reflected cognitive rather than affective considerations.

Although the statement: "Mathematics teaching is ... " was open to many interpretations, student responses indicate that they consider it important, but that there is plenty of room for improvement by teachers. Several students' responses highlight their expectation of being taught in a formal transmission mode.

While learning mathematics was regarded by more students as a negative rather than a positive experience, their comments showed a thoughtfulness and concern for overcoming difficulties, and a realisation of the necessity to complete prescribed courses.

Attitudes. Student attitudes towards mathematics overall and towards particular topics were more positive than negative. There was a preference for tasks that can be understood, completed, and that are relevant, while a few enjoy a challenge. Various preferences, such as having plenty of time, and group work were noted. Task complexity and test anxiety contributed overwhelmingly to negative attitudes. Teachers' insensitivity to student needs or feelings was noted by several as causes of negative attitudes (especially being rushed), as was repetitiveness in some cases. Students also pinpointed their own inadequacies as learners as contributing factors. It is interesting to contrast the generally positive attitudes towards mathematics with the negative beliefs about learning mathematics and the process of teaching it. Perhaps this is because the attitude statements were seen by respondents as being able to be qualified with preferences, whereas beliefs were more stable in their nature, and their objects more fixed.

Emotions

The results from this section show that emotions are fundamentally concerned with gaining complete understanding and the ability to complete successfully problems which are set. The overwhelming number of negative responses indicates that this cohort of students has

not been given the opportunity to gain mastery over the mathematics to which they have been exposed, and that they feel some degree of anguish over this state of affairs.

Conclusion

This study has shown that the cohort of students entering a TAFE applied science course has significantly different beliefs from those entering university science or engineering courses. It has also shown that the students exhibit attitudes and emotions related to caring about the teaching and learning of mathematics, but that they have generally not achieved the degree of understanding that they would have wished for in secondary education. This may be largely due to the constraints of completing set curricula in limited amounts of time, year after year. The document A National Statement on Mathematics for Australian Schools (Australian Education Council, 1991) states the following:

> An important aim of mathematics education is to develop in students positive attitudes towards mathematics and their own involvement in it ... The notion of having a positive attitude towards mathematics encompasses both liking mathematics and feeling good about one's own capacity to deal with situations in which mathematics is involved. (Australian Education Council, 1991, p. 31)

While the results give cause for some optimism there is clearly a long way to go in the compulsory years of education. Students in this survey have articulated their desires to understand the mathematics with which they are presented and to be allowed sufficient time to do so. McLeod (1992) has noted recent attempts to incorporate affective factors into research into the cognitive domain. TAFE teachers of mathematics subjects would do well to consider the affective domain of their students, and the complex sets of feelings they bring with them on enrolment.

Further Research

An avenue of further research could be into the effects of competency-based training, currently being introduced into the TAFE sector, on mathematics students such as these. (The funding implications for unrestricted completion time could be problematic.) This study has focused on Applied Science students; another comparative study could focus on Business Studies, Engineering or other TAFE students required to continue their mathematics

education. Further research could be also carried out to compare findings in the affective domain between those students who completed VCE Mathematics under the original and subsequent study designs.

References

Australian Education Council (1991). *A national statement on mathematics for Australian schools*. Melbourne: Curriculum Corporation.

Crawford, K, Gordon, S., Nicholas, J., & Prosser, M. (1993). Learning mathematics at university level: Initial conceptions of mathematics. In B. Atweh, C. Kanes, M. Carss, & G. Booker (Eds.), *Contexts in mathematics education (pp. 209-214)*. Brisbane: MERGA

Leder, G. (1993). Guest editorial: Attitudes to mathematics. *Mathematics Education Research Journal, 4*(3), 1-7.

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, NY: Macmillan.

Victorian Curriculum and Assessment Board (1990). VCE Mathematics study design. Melbourne: VCAB.

Wood, L. N., & Smith, N. F. (1993). Students' ideas about mathematics. In B. Atweh, C. Kanes, M. Carss, & G. Booker (Eds.), *Contexts in mathematics education (pp. 593-597)*. Brisbane: MERGA.