AFFECTIVE CONSTRAINTS ON CONSTRUCTION IN MATHEMATICS EDUCATION

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Students often feel constrained in their attempts to do mathematics because of their fear of failure or their lack of confidence. As well, some contextual factors inhibit understanding and enjoyment in mathematics. The way in which they perceive mathematics and learning mathematics has an impact on their success in the subject.
Following a smaller scale survey of beliefs concerning mathematics held by primary and secondary students and teachers, this study looks in more detail at a larger sample of over 2000 secondary school students, makes further comparisons and suggests trends in beliefs of students at secondary school level.
The analysis of data is presented under several headings, including:

Students' beliefs concerning
(i) their mathematical success and/or failure;
(ii) the nature of the mathematics learned;
(iii) the learning of mathematics in relation to other subjects;
(iv) learning geometry; and
(v) parental expectations.

This current study confirms most of the findings from the previous study, particularly in relation to students' beliefs that mathematics is mostly facts and procedures which have to be memorised and that everything important about mathematics is already known by mathematicians.

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Too many numbers,
Too many signs,
Too confusing for the mind!
Too much to think about.
Too much to know.
And it is boring, 'cause I say so!

- Rosemary, Year 7

Is this how all high school students see mathematics? How is Rosemary being affected by her view of mathematics?

Certainly, her poem implies that she does not find any enjoyment or success in mathematics. One can only surmise possible reasons for this but it is alarming to think that she has such negative views of the subject that she is willing to write them in a poem to which others had access. Nor was she alone in her class. Approximately half the class wrote poetry in a similar vein.

Rosemary's poem implies several beliefs about mathematics as she experiences it - and, after all, that is the way that everyone develops his or her beliefs about mathematics. From her emphasis

on numbers, it seems reasonable to assume that Rosemary believes that mathematics is just arithmetic. This seems to be a fairly common belief among school students at all levels. The fact that so many people, including the general community, appear to believe that mathematics is just arithmetic could be the result of several factors. These include the past lack of geometry and other branches of mathematics in school syllabuses, particularly in the primary syllabus. Or it could be the result of the emphasis placed on numerical computations in public statements and tests such as the Basic Skills Tests. Whatever the cause, such a belief not only downgrades other branches of mathematics, but it also inhibits students from gaining rich experiences which are related, sometimes more directly than arithmetic, to their everyday life.

Rosemary's emphasis on signs, while again indicating a belief that mathematics is arithmetic, also indicates a belief that mathematics is highly symbolic. Of course, this is so. The indication is, however, that Rosemary sees that symbolism only in relation to arithmetic and does not appreciate the richness, beauty and usefulness of mathematical symbolism in general.

The reference to mathematics being confusing could refer to the 'signs' or it could be a general statement indicating a feeling of helplessness in relation to the subject. Either way, the damage which has been done to Rosemary's perception of herself as a mathematician is obvious. It is all 'too much'! She may as well have said, "I can't think when I see all these signs. I can't learn it." How little confidence she has in herself and in her ability! How destructive of her self-image!

The final bold, almost defiant statement about boredom could be seen as an attempt to justify her previous comments. This implies a certain feeling of guilt, or even rebellion, against anyone who might have counter beliefs to hers. It does emphasise the extremely personal nature of one's engagement with mathematics, or any subject, for that matter. It seems, however, that mathematics arouses more polarised feelings and beliefs that most other subjects.

As has been indicated, Rosemary is not alone in the feelings of helplessness, frustration and boredom which she has expressed in her poem. Rosemary in her time will leave school, take up a vocation, perhaps marry and have children and become part of the general community without ever having the opportunity to experience mathematics as a relevant, interesting, exciting subject. Perhaps this is why the general community of the present appears to have certain beliefs about mathematics and certain expectations as to what is taught in schools and what students should know as a result. The effect of these community beliefs appears to be that unrealistic and probably limiting expectations are placed on students and teachers, schools and school systems in general.

The first contact schools have with the community at large is through the parents of the children in the school. Consequently, some indication of parents' beliefs about mathematics and about their children's mathematics could provide possible trends. Once such trends are established, there may be strategies that can be employed to gradually change the beliefs of at least a few of the members of the general community towards more helpful ones.

Previous small scale research carried out by the writers (Southwell & Khamis, 1991) using a sample of 510 primary and secondary students and primary teachers indicated that the following beliefs were held:

1. You are either good at mathematics or not.
2. Answers in mathematics are either right or wrong.
3. If you do not get the right answer, you just start again.
4. Mathematics is important for every day life.
5. Memorising facts and procedures is the way to learn mathematics.
6. Mathematics is arithmetic.

In this previous study, the secondary section of the sample (310 subjects) were all female. The question arises, then, as to whether male students have different beliefs about mathematics and about themselves as mathematicians. Also how are they affected by the beliefs their parents hold? These formed the basis of the research questions for the current study. They were:

1. Do male secondary school students hold the same beliefs about mathematics as their female counterparts?
2. Do male secondary school students see themselves as mathematicians in the same way as female secondary students do?
3. Do secondary school students have perceptions of their parents' beliefs about mathematics which are different from their own?

The Sample

As the secondary section of the sample in the previous study was totally female, it was felt that a sample of both male and female respondents may provide more specific information. Consequently the secondary survey instrument was administered to a larger sample from six schools consisting of both male and female as indicated in Table 1.

School	Female Students	Male Students	Total
School 1	175	219	395
School 2	243	246	493
School 3	193		193
School 4	355		355
School 5		367	367
School 6	183	158	344
TOTAL	1149	990	2129

Table 1. Distribution of Sample

The Survey Instrument

The survey instrument used consisted of items adapted from Schoenfeld(1989) and Way (1990). Information was sought on secondary school student' beliefs concerning:

(i) their mathematical success or failure;
(ii) the nature of the mathematics learned;
(iii) the learning of mathematics in relation to other subjects;
(iv) learning geometry; and
(v) perceptions of parental expectations.

The subjects were asked to respond to each item on a four part Likert scale ranging from "1= very true" to "4 = not at all true". As well a number of open-ended questions gave students the opportunity to express their views without constraints.

The Analysis

The analysis of the responses of the 2147 subjects was carried out by finding means, standard deviations and significance levels for the responses made by female and male subjects. In general, the analysis followed similar trends as in the previous study. There were, however, differences of interest. These differences are reflected in the difference in the male and female responses in the current study, since all secondary school respondents in the earlier study were female.

A t-test was used to compare mean responses for females and males.

Results

Significant differences ($p < .001$) occurred in the responses concerning reasons for getting good grades. These are shown in Table 2. The difference between female and male students is significant ($p<.001$) on all five reasons with the highest response being the perception that good grades are achieved because of the teacher's liking of the student. Allied with this is the significant

($p<.001$) result that the main reason for trying to learn mathematics is 'to make the teach think I'm a good student'.

	Totals N = 2147		Females N = 1158	Males N = 974	Signif Level
	Mean	S.D.	Mean	Mean	
1. It's because I worked hard.	1.5	.6	1.5	1.6	$p < .001$
2. It's because the teacher likes me.	3.6	.6	3.6	3.5	$p < .001$
3. It's just a matter of luck.	2.8	.8	2.7	2.9	$p < .001$
4. It's because I'm always good at mathematics.	2.6	.8	2.7	2.5	$p < .001$
5. I never knew how it happened.	3.1	.8	3.1	3.2	$p < .001$

Table 2. Students' Beliefs About Why They Get Good Grades in Mathematics

The reasons for getting poor grades were not so divided with the only significant results being the responses "Because the teacher doesn't like me" and "Because I'm just not good at mathematics". The differences between male and female responses are given in Table 3. This shows the high response again concerning the teacher's liking or dislike of the student being a critical factor.

	Totals N = 2147		Females N = 1158	Males N = 974	Signif Level
	Mean	S.D.	Mean	Mean	
1. It's because I didn't study hard enough.	1.6	.7	1.6	1.6	-
2. It's because the teacher doesn't like me.	3.5	.7	3.6	3.4	$p < .001$
3. It's just bad luck.	2.9	.8	2.9	2.9	-
4. It's because I'm just not good at mathematics.	2.8	.9	2.7	2.9	$p < .001$
5. It's because of careless mistakes.	1.7	.7	1.7	1.8	$p < .05$

Table 3. Students' Beliefs About Why They Get Bad Grades in Mathematics

No great differences were indicated in the female and male students' beliefs about the nature of the mathematics they learn. There is a difference, however, in the responses of the females in the current study and those in the previous one. The current respondents are not as convinced as the previous one that mathematics is thought provoking.

While both groups of students feel that "good mathematics teachers show students the exact way to answer mathematics questions you'll be tested on", their responses were significantly different ($p< .001$). As well, the female respondents were more convinced of this than those in the previous study.

Female respondents believe that "some people are good at science and some just aren't". Their response is significantly different from the males ($p < .01$). Despite this, the difference between female and male respondents' belief that good science teachers show students the exact way to answer questions is not as significant ($p < .05$).

The t-test indicates that there is a significant difference ($p<.01$) between the degree to which females and males believe that 'everything important about mathematics is known already by mathematicians' This result is apparently inconsistent with the another significant difference between females and males. This is that things can be discovered about geometry without being taught ($p < .001$). This latter result appears to be supported by the difference between female and male students on the degree to which 'you can be creative and discover things for yourself" ($p<.05$). In contrast, both female and male respondents believe that they can only verify something a mathematician has already shown to be true.

Although both females and males believe the best way to do well in mathematics is to memorise all the formulas, the difference between females and males is significant ($p < .01$). This is consistent with the difference ($p < .001$) between females and males in beliefs about geometrical constructions and the necessity to memorise the way to do them. Learning geometry as a means of better understanding mathematical thinking differs for female and male students ($p < >01$).

There is a significant difference between females and males in the way in which they respond to getting wrong answers. While both tend to 'start all over in order to do it correctly', females seem to do this more readily than males.

Perceptions of students about their own mathematical ability and about their parents' expectations for them differ between female and male students in several aspects. Females see themselves as being average students more than males do ($P<.01$). Females tend to complete their homework more often than males ($p < .001$). Males believe it is more important to do well in mathematics than females do($p<.01$). Both mother's and father's perceptions of the importance of mathematics are seen to be greater by males ($p<.01$).

Some items in the survey which invite some attention are some in which there is no significant difference between female and male respondents and some which reveal a high response. In both categories are getting bad grades because of not studying hard enough or because it is just bad luck, the belief that mathematics is mostly facts and procedures that have to be memorised (significant at .05 level), the belief that some people are good at mathematics and some are not,

that in mathematics something is either right or wrong. This last belief is also held for science though not for English. Other beliefs held are that mathematical problem solving is important for everyday life, that mathematical thinking is what we do in solving problems, and working in groups is helpful. At the same time both females and males report that they do not often work in groups. Both females and males, however, appear to want to do well in mathematics.

Discussion

The reasons given by female and male students for getting good and bad grades follow the generally accepted view that females attribute their success to working hard and luck while males attribute their good results to being good at mathematics as well as working hard.. The interesting aspect of these current results is the significant role played by teachers in the students' perception of their success and failure. They believe they get good or poor results because the teacher either likes them or not and they want to learn mathematics so the teacher will consider them a good student. There is no mention of the content being learnt and taught and nothing about the quality of the teaching. It seems to be the personality of the teacher which is being referred to. Such a major influence played by the teacher could be due to several reasons. These include the low perceptions which the students have of their own ability which makes them see the teacher as being the holder and dispenser of all wisdom in relation to mathematics. This is supported by other beliefs held that mathematics is basically facts and procedures which have to be memorised. The teacher is the assessor then to determine the degree to which these facts and procedures have been memorised. This also links with the belief that good mathematics teachers will show students the exact way to answer mathematics questions they will tested on.

While no significant gender differences were observed in the respondents beliefs about mathematics itself, the trend was to see mathematics as mostly facts and procedures that have to be memorised. This was emphasised also in relation to geometrical constructions.

The beliefs that mathematics is a subject in which there is nothing more to learn, a subject in which you either get the right answer or you are wrong and that you are either good at mathematics or you are not indicate a very limited view of mathematics and mathematicians. This could be because school syllabuses are very tightly structured and the demands of public examinations inhibit the methods and content introduced by teachers.

In contrast to beliefs about ability to do mathematics and science is that concerning English. This supports the view that these subjects are seen as different kinds of subjects to English.

Again, the emphasis seems to be on being right or wrong. When one gets a wrong answer, the tendency is to start over again and not to use the work already done. As has been shown in computer programming, the process of de-bugging is a very useful one in helping the programmer become more skilled. This has not carried over into other areas of education. This is true in mathematics possibly because of the limited view the respondents have of mathematics as a discipline and also because of their own lack of confidence in themselves as mathematicians.

The result that the perception of both female and male students that their mothers consider mathematics important less than their fathers seems to indicate that the community in general has not moved very far towards equal opportunity for all students.

Conclusion

This preliminary analysis of survey responses from over two thousand students has highlighted some issues which support previous findings. It also raises some issues, such as that of the role of the teacher which will need to be investigated more thoroughly. For further exploration, also, is the question of whether there are any significant differences between the responses of the females in all girls schools and those of females in co-educational schools. A similar question arises in relation to male students in all boys schools and those in co-educational schools. The one heartening point in contrast to Rosemary's poem is that the respondents do want to learn mathematics. It is up to teachers to ensure that the mathematics they learn is enjoyable, exciting, useful and challenging.

References

Australian Education Council National Statement on Mathematics for Australian Schools. Canberra: Curriculum Corporation.

Schoenfeld, A., (1989) "Explorations of Students' Mathematical Beliefs and Behaviour." *Journal for Research in Mathematics Education.* Vol 20, No 4, July, pp 338-355.

Southwell, B. & Khamis, M. (1991). 'Affective Considerations in Assessing Mathematics". in Izard, J.(1991). *Assessment in the mathematical sciences.* Melbourne: ACER.

Way, J. (1990). *Group work: Teachers' attitudes and practices.* Unpublished MEd project.