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"DO YOU PANIC ABOUT MATHS?"

Review by Foong Pui Yee

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INTRODUCTION

"Do you panic about maths?" was a question Laurie Buxton (1984) asked in his book of the same title. He studied ten articulate and intelligent adults who had left school with unpleasant memories of their mathematics learning. Most of them felt "panic" when they were each given a mathematical problem to solve. It brought back the image of a classroom situation that was not far from the feelings depicted in the cartoon above.

It is a common notion that of all the subjects taught at school, mathematics provokes the strongest emotions of dislike, anxiety and low self-concept in those students who do not seem to achieve some level of success in it. Why does mathematics have such an effect on people? Why should mathematics appear so difficult to many people?

School mathematics is characterised by abstract content that does not resemble other school subjects. This feature becomes especially evident when comparing mathematics with subjects such as history and geography. To master the latter subjects one kind of activity often predominates, namely storing or memorising information.

On the other hand, the learning of school mathematics is marked by a variety of kinds of activity such as early number concept formation through modeling with concrete objects, mastery of computational and measurement skills, mental calculation, spatial thinking and problem-solving. All of these are necessary for mastering the material under study. One of the major goals of mathematics education in school is to enable students to use the mathematical content and the skills learnt, to apply them to the solution of practical problems.

In a traditional classroom, mathematics learning is often a highly procedural activity. Teachers usually transmit patterns of activity to students by presenting mathematical problems whose solutions involve these patterns. This could be due to a feature unique to mathematics that is the logical organisation of its contents. It involves a hierarchical structure where learning has to proceed as such. To reach any particular branch, it is necessary to go a long way along the whole mathematical tree. For instance it is impossible to learn differentiation without mastering transformation of algebraic expressions, transformations without mastering the arithmetic of fractions, and fractions without knowledge of the multiplication table, and so on. Cumulative failure can be experienced by a child who does not get it right at step one as he moves on in school mathematics. Also, unlike other subjects where answers to questions can be open-ended, in mathematics it often demands 'right' or 'wrong' answers. For those who know and provide the correct answer in the mathematics classroom, it may be a pleasant experience. But for those who do not know the answers most of the time, mathematics learning can be a source of discomfort that leads to negative attitudes towards it.

REVIEW OF RESEARCH

Many researchers have investigated the relationship between the affective domain in mathematics education and achievement in mathematics. In these research studies, attitudes, beliefs, and emotions have generally been used to describe a wide range of affective responses to mathematics (McLeod, 1992). The use of these terms varies according to the stability of the affective responses that they represent. ***Attitudes,*** which sometimes include beliefs, are generally stable. An attitude is the tendency to respond favorably or unfavorably to a given situation or object. A student may like geometry and not like fractions, or he may prefer discovery learning to direct teaching. ***Beliefs*** are shaped by school experience over a relatively long period of time. For example a student may believe that mathematics problems have one and only one right answer or a belief about oneself being unable to solve any word problem. On the other hand, ***emotions*** involve little cognitive appraisal and may appear or disappear rather quickly depending on the situation at hand. For instance panic or anxiety may be aroused if the student encounters a problem and has no idea where to begin and this may give rise to joy when he eventually solves the problem.

Schoenfeld (1989) also believes that an individual's performance on a mathematical task is very much influenced by a host of affective factors, at times to the point of dominating the individual's thinking and actions. Mcleod (1989) pointed out that research on the cognitive processes in mathematical problem solving

has been over-represented resulting in a neglect of non-cognitive factors such as emotions and anxiety. The acquisition of mathematical problem solving skills is very important because it is an ability that people need throughout life. Problems for students arise when they attempt to understand mathematical concepts and relationships as well as to apply them judiciously in novel situations. In mastering problem solving skills, interruptions and blockages are an inevitable part of the learning process; students will experience both positive and negative emotions. If the student is unable to overcome the blockage, an emotional response such as frustration will arise. And when the student has experienced repeated failure in a given mathematical situation, that student's response in a similar situation in the future may be "I do not like Maths" or "I cannot solve any Maths problem." This student has developed an attitude toward mathematics and in this case it is a negative one. In a study of the characteristics of good problem solvers in mathematics, Suydam (1984) found that high achievers usually had higher scores for self-esteem and confidence. They were less test-anxious and enjoyed good social relationships with their peers.

It is generally assumed that a strong relationship exists between affective responses and achievement in mathematics. It is a common belief among educators and others that children learn more effectively when they are interested in what they learn and that they will achieve better in mathematics if they like mathematics. Current efforts in reforming mathematics curriculum and instruction have placed a special emphasis on this relationship. It is also stated in the Singapore mathematics curriculum that one of its aims is to develop in students positive attitudes and a sense of personal achievement in mathematics.

Attitudes and Mathematics Anxiety

To assess the magnitude of the relationship between attitudes toward mathematics and achievement in mathematics Ma and Kishor (1997) conducted a meta-analysis to integrate the findings of 113 primary studies. They found that the effect of attitude on achievement was not strong. However, the relationship between attitude and achievement was dependent on a number of variables. Three significant variables were: grade, ethnic background and gender. A significant finding was that the relationship was not strong at the primary grades but was significant at secondary levels. Ma and Kishor attributed this to the fact that at lower primary, the attitudes toward mathematics tend to be unstable because students are unable to express their feelings precisely. They suggest that the period of schooling from upper primary to lower secondary onwards however is critical, as this is when students begin shaping their attitudes towards mathematics. They believe this is the time when negative attitudes become especially noticeable for teachers to address the problem. However, by the time the students reach the upper secondary and Junior college period, they may hold more fixed or stable attitudes that tend to affect less or be less affected by their achievement in mathematics. The meta-analysis results also showed that the attitude-achievement relationship is significantly stronger for Asian students than for Caucasian or Black students. In their review of literature, Ma and Kishor were aware that attitudes toward mathematics can be culturally shaped and reinforced. They suggested that separate analyses by sex should be conducted, as the girls' mathematics marks were more

predictable from their attitudes than boys' marks. The attitudes-achievement correlation was generally higher for the girls.

In another study on mathematics anxiety, Foong (1987) found that highly mathematics anxious secondary female students were associated with low mathematics achievement. Labels such as 'math anxiety' or 'mathphobia' attempted to determine if there is actually a set of emotions that can be broadly conceptualised as anxiety towards mathematics. Math anxiety or mathphobia was defined as the experience of mental disorganization, panic, and fear that prevents a person from learning mathematics (Buxton, 1984). She concluded that some students are anxious about mathematics, which they find difficult and threatening. They may perceive their inability to handle mathematics problems with feelings of self-doubt, fear of failure and loss of regards by others.

In a further study on behavioral traits in mathematical problem solving, Foong, (1992) identified from factor analysis, affective responses that tended to distract rather than enhance successful problem solving. For many of the unsuccessful solvers, the initial perception of the problem as difficult aroused a certain level of anxiety and confusion, even before they set to work on the task. Subsequently when their attempts at solutions did not produce the results, they became frustrated and showed a lack of self- confidence. They would either continue in a rambling manner or they would give up, thus avoiding further frustration. Buxton (1984) identifies three emotional states underlying mathematics anxiety:

i. *irritation* can arise from ideas that do not fit one's perception or common sense. Due to the abstract nature of mathematical ideas, many students find them difficult to accept unless they can be related to real situations, e.*g. the product of two negative numbers is positive;*

ii. *bewilderment* arises from failure to comprehend and make connections. A common reaction is: *"What is it all about?";*

iii. *frustration* can arise with repeated failure in problem solving when no strategy can be derived to tackle the problem.

Beliefs about mathematics and attributions

Leder (1993) and Kloosterman (1991) are of the view that beliefs shape attitudes and emotions and that they greatly affect the disposition of students towards mathematics. Over the years, considerable attention has been directed towards research on students' beliefs about mathematics as a subject, about self in the learning of mathematics, about mathematics teaching and about the social context of classroom instruction. Schoenfeld (1989) has pointed out that students' beliefs about mathematics may weaken their ability to solve non-routine problems. If students believe that mathematical problems should always be solved in five minutes or less, they may be unwilling to persist. Stodolsky (1985) describes how beliefs about mathematics influence how students and teachers perform in elementary school mathematics classrooms, as compared to social studies classrooms. In mathematics classrooms

students spend a great deal of time working alone in 'seatwork'. They tend to believe that doing mathematics means memorising formulae and directly applying rules that are taught to solve problems. Whereas in social studies, students are more likely to work in groups, to develop their research skills and to work on tasks compatible with the development of higher-order thinking. In contrast, the limited views students have about mathematics, including the belief that mathematics learned in school has little or nothing to do with the real world, can lead to mathematics anxiety and more generally hinders higher order thinking in mathematics. It is through the years of watching, listening and practising in the mathematics classroom that students acquire these counter-productive beliefs.

In relation to research on beliefs about mathematics, there are a number of recent studies on causal attributions among mathematics students of different cultures and genders. Individuals are said to have an 'internal locus of control' when they attribute outcomes to their own abilities or effort whereas for 'external locus of control' they attribute outcomes to factors outside themselves and beyond their control such task difficulty or luck. Males are more likely than females to attribute their success in mathematics to ability whereas females are more likely to attribute their success to effort. On the other hand, males tend to attribute their failure in mathematics to lack of effort while females to the lack of ability and the difficulty of the task. Ames and Archer (1987) found that elementary students who attributed success to effort were more likely to exhibit a mastery orientation, putting their emphasis on learning and understanding through hard work, meeting challenges and making progress. Students who attributed success to ability were more likely to be interested in good grades than in understanding. Unfortunately when students attribute their failure to lack of ability, they may eventually develop a pattern of behaviour called "learned helplessness". Learned helplessness includes feelings of incompetence, lack of motivation and low self-esteem. When a mathematics anxious student sees that a problem is not going to be easy to solve, he tends to quit right away, believing that no amount of time or re-reading or re-formulating of the problem will make it any clearer. Comparison between Chinese, Japanese and American children, (Lee, Ishikawa & Stevenson, 1987) indicates that Japanese mothers believe that effort is the most important criterion in determining the school achievement of children while American mothers credit ability as being the most important. If a child believes more effort will result in getting the correct answers, more effort is probable. If a child feels ability determines the outcome, then persistence is not seen as relevant.

CONCLUSION

The important role of affective variables in the mathematics classroom is evident from the review of research in this article. Teachers and researchers need to seek answers to the questions of when and how affective variables develop in the course of a student's mathematics education from year one till he or she leaves school. Teachers must assess the attitudes and beliefs of students in their classroom. They must analyse their own teaching behaviours as well as seek how to foster the development of positive attitudes and beliefs towards the learning of mathematics.

IMPLICATIONS FOR THE CLASSROOM

Renga and Dalla (1993) offer the following suggestions for teachers of mathematics to combat negative attitudes, beliefs and math anxiety in students:

- ***Show an enjoyment for mathematics yourself.***
  Make mathematics fun through the use of concrete models and discovery lessons. Demystify mathematics by creating appropriate classroom environments where students perceive mathematics as sense-making activity and are able to see connections across topics and in real-life context.

- ***Give students opportunity to communicate mathematics through journal writing.***
  Writing about how they feel about a lesson, what they have understood and how they solve a problem will provide teachers with a deeper understanding of their students' thoughts and feelings in and out of the classroom. Provide positive feedback that focuses on what students do right and treat mistakes as a normal part of learning

- ***Model problem solving strategies rather than model-answers or techniques.***
  Let students present suggestions, try their ideas and let them see why they do or do not work. Allow students to participate interactively through cooperative small group discussion and problem solving. Teach students to be mathematicians at their own level rather than teaching them to just learn to perform routine operations.

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