Assessing Singapore Students' Attitudes toward Mathematics and Mathematics Learning: Findings from a Survey of Lower Secondary Students

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Students' attitudes toward mathematics and mathematics learning and their implications for mathematics instruction have long been a commonly shared interest among mathematics educators. To assess Singapore students' attitudes toward mathematics and mathematics learning, we have recently conducted, as part of a larger research project, a survey of more than one thousand secondary students in eight schools. Overall, the results suggest that Singapore secondary students have generally positive attitudes toward mathematics and mathematics learning. However, they hold relatively negative attitudes about work on challenging problems and about the usefulness of mathematics in their adult life. The paper also includes discussion on the implications of the findings from the survey for the teaching and learning of mathematics and offers relevant suggestions.

Key words: mathematics, mathematics learning, attitude, performance, secondary.

Introduction

Students' attitudes toward mathematics and mathematics learning and their implications for mathematics instructions have long received much attention from both mathematics educators and mathematicians (e.g., see Royster, Harris, & Schoeps, 1999). In particular, the relationship between attitudes toward mathematics and achievement in mathematics had traditionally been a major concern in mathematics education research (Ma & Kishor, 1997). For example, Neale (1969) describes the relationship between the two as a consequence of a reciprocal influence, that is, attitudes affect performance and performance in turn affects attitudes. On the other hand, There is research reporting that the relationship is not statistically significant (e.g., Ng-Gan, 1987; Papanastasiou, 2002). There is also research evidence showing no causal relationship between attitudes and performance. For instance, the Third International Mathematics and Science Study (TIMSS) reveals that while Japanese students outperform students from many other countries, they have negative mathematics attitudes (Mullis et al., 2000). Nevertheless, the crucial role of developing positive attitude in mathematics learning has been widely recognized. In fact, many countries have set it as one of the aims of mathematics education in schools. In the case of Singapore, the national mathematics curriculum states "mathematics education aims to enable pupils to … develop positive attitudes towards mathematics including confidence, enjoyment and perseverance" (Ministry of Education [MOE], 2000, p. 9).

The present study is intended to investigate Singapore students' attitudes towards mathematics and mathematics learning at the lower secondary level. There are three reasons for us to conduct this study. First, as developing students' positive attitudes is

stipulated as one of the main aims for mathematics education in Singapore, we want to measure how low secondary school students have achieved in this aim. Second, as part of a large research project on integrating new assessment strategies, we hope to assess students' attitudes before the implementation of the new strategies to provide a benchmark in this important aspect of students' affective domain for future comparison and improvement. Third, although many believe that attitudes play an important role in students' learning of mathematics, there has been little effort on studies about students' attitude toward mathematics and mathematics learning in Singapore's educational settings. In fact, the majority of the available studies on this issue are carried out in the western countries.

Population and Sample

To investigate Singapore students' attitude toward mathematics and mathematics learning, this study uses a questionnaire survey to collect responses from 1215 secondary one students.

In Singapore, four types of courses/streams are provided at the secondary level, including Special (SP), Express (EXP), Normal Academic (NA), and Normal Technical (NT), for students to choose mainly based their abilities measured in their primary school leave examinations (PSLE). According to the statistics, about 85% of students undergo the SP, EXP or NA course, while the Normal Technical course takes the least percentage of students (MOE, 2004). Moreover, not many secondary schools offer the NT course due to the small population. In view with the fact that the majority of students are enrolled in the first three courses, this study focuses on students' attitudes toward mathematics and mathematics learning from those courses. Secondary one students are selected for the survey.

To make the results more representative, this study selected schools from both high-performing and non-high performing cohorts. High performing schools are identified as those ranked in the first 50 best performing schools according to year 2001 and year 2002 GCE "O" Level Examination (General Certificate of Education) results released by the MOE; while the non-high performing schools are the remaining ones. Four high-performing and four non-high performing schools are then selected using a random stratified method. Four classes from each school (except for one school, from which only three classes) took the survey. As a result, a total of 1215 secondary one students participated in the question survey, comprising students taking SP, EXP, or NA courses.

Instruments

The aim of the survey is to investigate students' perceptions about the subject mathematics and the value of mathematics learning. Therefore, the questionnaire is specifically designed into four aspects consisting: general view towards mathematics and mathematics learning, the anxiety level in the learning of mathematics, students' perceptions of their own performance in mathematics, and students' beliefs about the usefulness of mathematics. In all, 22 items are developed using a nine-point Likert Scale ranging from "disagree totally" to "agree totally". Each aspect comprises six items except the aspect on students' beliefs in the usefulness of mathematics, which only has four items.

A total of 65 secondary one students from two schools from the population but not the sample participated in a pilot version of the survey on 8 and 9 January 2004. The pilot shows that the questionnaire can be completed within a reasonable short period of time. Overall, students do not have much difficulty in answering the questions but on some items, phrasing is modified in the final version for easier and clearer understanding. A reliability test was done and two questions were finally removed from the pilot version in order to increase the reliablity level.

Data collection

The questionnaire was distributed to all the participating classes from the eight sample schools in February/March 2004 and the teachers in the respective schools took the responsibilities in administering the survey. The completed questionnaires were collected in April 2004, with a response rate being 97.6%.

Data processing and analysis

The data from the survey were analyzed using quantitative methods. Descriptive statistics, such as mean and percentage, was used to delineate how students view the subject of mathematics, the perception of their anxiety and ability in mathematics, and their beliefs in the usefulness of mathematics as well.

Results and Discussion

The results of this study are reported based on the four categories identified above, including the reliability and item-total correlations of the items. That is, students' general view towards mathematics and mathematics learning, students' anxiety level in the learning of mathematics, students' perceptions of their own performance in mathematics, and students' beliefs about the usefulness of mathematics.

Students' general view towards mathematics and mathematics learning

For students' general view, six items were particularly designed, which had a high Cronbach's Alpha of 0.89 and the item-total correlations averaged 0.72 with a range of 0.51 to 0.82.

The data show that students generally feel that mathematics is interesting to them (73%) and they enjoy doing mathematics (74%). However, interestingly, only about 63% of students like to attend mathematics lessons and less than half of the students (49%) like spending time on studying mathematics. Moreover, 37% of the students respond that mathematics is hard for them and 22% don't have good feeling about mathematics.

The result appears to us that students feel mathematics is an interesting subject and they seem to like to engage in doing mathematics; however, they do not want to spend too much on doing so. It might be because that the mathematics students learnt from schools is somehow examine-oriented and many of the mathematics questions are routine and close-ended. For instance, one analysis on Singapore primary mathematics textbook series reveals that 99% of the text problems are routine problems and open-ended problems only account for 2.6% in all the text problems (Ng, 2002). Similar results are also obtained in another textbook analysis on one Singapore mathematics textbook series at the lower secondary level (Zhu, 2003).

Students' maintaining interest toward mathematics could be due to certain activities they are engaged in during curriculum time, math trials and project work for examples. The fact that some students could easily get high marks after much practice in mathematics might also attribute to their liking of mathematics. However, recent emphasis of including more mathematics problems in unfamiliar context and open-ended investigations which students are not fully used to yet may lead them to have relatively negative feeling about mathematics and their learning in mathematics. We believe that giving students more opportunities to engage in a wider range of activities in mathematics learning will further motivate students' learning enthusiasm and interest.

Students' anxiety level in the learning of mathematics

There are six items measuring students' anxiety level in mathematics learning and a reliability test on these items yields a moderately high Cronbach's Alpha of 0.81 and the average item-total correlation is 0.58 with a range of 0.50 to 0.68.

It is found that students are generally anxious about their mathematics learning. In particular, more than 30% of the students have the feeling of being stressed when they attend mathematics lessons and about the same percentage of students claim that they cannot think clearly, feel lost, and are nervous when doing mathematics problems. Furthermore, about 22% of the students are afraid of doing mathematics and 30% do not have confidence when it comes to mathematics.

It is not surprising to see that students are anxious about their mathematics learning, as mathematics is a core subject in schools. In one aspect, we can view students' relatively high level of anxiety as a positive sign indicating that students are serious about the subject. However, we believe that high anxiety may have negative influence on learning. In fact, researchers tend to associate "mathematics anxiety" with debilitating test stress, low self-confidence, fear of failure, and negative attitudes toward mathematics learning (Bessant, 1995). Ma's (1999) meta-analysis of 26 studies on the relationship between anxiety toward mathematics and achievement in mathematics at the primary and secondary school levels reveals that there is a significant relationship between the two variables – lower mathematics anxiety gives the potential of higher mathematics achievement.

Students' perceptions of their own performance in mathematics

This category has six items. A Cronbach's alpha of 0.84 shows a moderately high internal consistency for these items with the item-total correlations ranging from 0.43 to 0.73 giving an average of 0.64.

Interestingly, students' responses reveal that they believe that they have ability to perform and perform well in mathematics. The corresponding data show that 77% of the students are sure that they can learn mathematics well and 61% believe that they can get good grades in mathematics. However, consistently to the results in students' general view, many students do not like to solve challenging mathematics problems (31%) and rather have someone give them answers than to work on their own (24%).

Singapore students' confidence in their mathematics performance might be somehow related to the examination-oriented style of teaching. Simply, what is to be tested will be what is to be taught and in turns what to be learnt. In this aspect, students are confident and well prepared with the examination, as they know what are to be

expected and the knowledge beyond classroom teaching is seldom to be tested. Moreover, the emphasis on practice and more practice will surely result in good grades, which seems to be the general mentality of both teachers and students. In addition, the TIMSS results further reconfirm that Singapore students perform very well in solving mathematics questions which are target on students' procedural knowledge and routine problem solving skills (e.g., Bracey, 2000; Wang, 2001, Toh and Pereira-Mendoza, 2002). In contrast, as shown in the questionnaire survey, when students come to challenging problems, many are reluctant to try but rather get help from others. School teachers may want to provide more opportunities for students to work on more challenging and non-routine tasks and recognize the importance of the practice of higher-order thinking so as to fully develop students' mathematics learning ability.

Students' belief about the usefulness of mathematics

As reported earlier, only four items are developed in this category with an internal consistency estimate of 0.79 (Cronbach's alpha) and the average item-total correlations of 0.61 ranging from 0.52 to 0.68.

It is good to see that the majority of Singapore secondary one students believe that mathematics is useful (91%), important (89%), and learning mathematics is not wasting their time (84%). However, only 64% of the students claim that they will use mathematics a lot as an adult.

The discrepancy between students' responses to the usefulness/importance of mathematics and whether they will actually use mathematics bring forth the following two thoughts: (1) What is students' thinking when they refer to mathematics being useful in their learning? and (2) How is mathematics important to them? High percentage of positive responses to the usefulness and importance of mathematics could possibly due to students regarding mathematics as a school subject and/or a functional tool. However, the survey does not provide evidence to show how many of the responses are meant for the latter. In our view, if the high percentage as a result of students regarding learning mathematics merely for passing examination without recognizing the value of mathematics in the practical sense, the results call for our careful reflection on what teachers have taught and what students have learnt in mathematics classrooms. The data on whether students will use mathematics a lot as an adult, in some extent, indicate that some students cannot see the functional aspect of mathematics in their adult life. Examining the mathematics textbooks, workbooks, or school test papers, one can easily find that the majority of problems that students work on have virtually no relevance to their daily life. It is therefore not difficult to understand why students view mathematics as a subject being abstract and not applicable to real life situation. We believe that there is a need to change students' views from learning mathematics just as a compulsory requirement in schooling to realizing the functional value of mathematics by exposing students to more authentic mathematics. As researchers have noted, it is important for students to comprehend the nature of mathematics in order to increase their desire to undertake challenging tasks which will potentially promote higher-order thinking (e.g., Carlson, 1999; Higgins, 1997; Schoenfeld, 1989, 1992).

Implications and Suggestions

This study investigates Singapore students' attitudes toward mathematics and mathematics learning via a questionnaire survey. The data are collected from more than one thousand lower secondary students. The results show that Singapore students in general hold positive views about mathematics and their learning of mathematics in terms of interest, anxiety, confidence, and belief. Meanwhile, the data also reveal that students are not very keen in working on unfamiliar and challenging mathematics problems and some students do not see the potential usefulness of mathematics in their future life.

The results from this study suggest that Singapore students know that mathematics is important and they seem willing to learn mathematics and to learn it well. However, school teachers must be aware that there are certain aspects of students' learning in mathematics needed to be improved. In particular, students should be given more opportunities to work on non-routine and challenging mathematics problems so as to maximize their higher-order thinking skills and value the intrinsic essence of mathematics (Yeo & Zhu, in press). Mathematics should not be limited to the representation of rigid processing, routine manipulation, and theoretical operation. In this sense, mathematics should be demonstrated in a more authentic way, by which students can spontaneously associate mathematics knowledge with their everyday environment. We believe that in doing so, the engagement and exposure will result in students' better understanding of mathematics and their mathematics learning, which in turn to help students to develop more positive attitudes toward the subject and therefore further promote their learning ability.

References

Bessant, K. C. (1995). Factors associated with types of mathematics anxiety in college students. *Journal for Research in Mathematics Education*, *26*(4), 327-345.

Bracey, G. (2000). The TIMSS final year and report: A critique. *Educational Research*, *29*(4), 4-10.

Carlson, M. P. (1999). The mathematical behavior of six successful mathematics graduate students: Influences leading to mathematical success. *Educational Studies in Mathematics*, *40*, 237-258.

Higgins, K. H. (1997). The effect of year-long instruction in mathematical problem solving on middle school students' attitudes, beliefs and abilities. *The Journal of Experimental Education*, *66*(1), 5-28.

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education*, *30*(5), 520-540.

Ma, X., & Kishor, N. (1997). Assessing the relationship between attitude toward mathematics and achievement in mathematics: A meta-analysis. *Journal for Research in Mathematics Education*, *28*, 26-47.

Ministry of Education. (2000). *Mathematics syllabus (primary)*. Singapore: Curriculum Planning & Development Division.

Ministry of Education. (2004). *Educational statistics digest 2003*. Singapore: Author.

Mullis, I. V. S., Martin, M. O., Gonzalez, E. J., Gregory, K. D., Garden, R. A., O'Connor, K. M., et al. (2000). *TIMSS 1999 international mathematics report: Findings from IEA's repeat of the Third International Mathematics and Science Study at eighth grade*. Chestnut Hill, MA: Boston College.

Neale, D. C. (1969). The role of attitudes in learning mathematics. *Arithmetic Teacher*, *16*, 631-640.

Ng, L. E. (2002). Representation of problem solving in Singaporean primary mathematics textbooks with respect to types, Pólya's model, and heuristics. Unpublished master thesis, National Institute of Education, Singapore.

Ng-Gan, L. C. (1987). Relationship between secondary school students' mathematics attitude and achievement. Unpublished master thesis, National University of Singapore.

Papanastasiou, C. (2002). Effects of background and school factors on the mathematics achievement. *Educational Research and Evaluation*, *8*(1), 55-70.

Royster, D. C., Harris, M. K., & Schoeps, N. (1999). Disposition of college mathematics students. *International Journal of Mathematics Education in Science and Technology*, *30*(3), 317-333.

Schoenfeld, A. H. (1989). Explorations of students' beliefs and behavior. *Journal for Research in Mathematics Education*, *20*(4), 338-355.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 340-370). New York: Macmillan.

Wang, J. (2001). TIMSS primary and middle school data: Some technical concerns. *Educational Researcher*, *30*(6), 17-21.

Yeo, S. M., & Zhu, Y. (in press). *Higher-order thinking in Singapore mathematics classrooms*. Paper presented at the Educational Conference: Redesigning pedagogy in research, policy, practice. Singapore: Centre for Research in Pedagogy and Practice, National Institute of Education.

Zhu, Y. (2003). *Representations of problem solving in China, Singapore and US mathematics textbooks: A comparative study*. Unpublished doctoral dissertation, National Institute of Education, Singapore.