

Singapore Enactment Project

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The *Enactment Project* is a Programmatic Research Project funded by the Ministry of Education, Singapore, and administered through the Office of Educational Research, National Institute of Education, Nanyang Technological University. The project began in 2016 and its aim is to study the enactment of the Singapore mathematics curriculum across the whole spectrum of secondary schools within the jurisdiction. There were two phases in the project: the first involved in-depth examination of 30 experienced and competent mathematics to draw out characteristics of their practices; in the second phase, we study the extent of these characteristics through a survey of 677 mathematics teachers. A symposium was organised in MERGA 42 in 2019 where the foundational elements of this project were presented; we would like to share more findings of this project in this year's conference.

Paper 1: Berinderjeet Kaur *Models of mathematics teaching practice in Singapore secondary schools*

This paper revisits the models of mathematics teaching practice that were proposed by earlier researchers of the Singapore mathematics classrooms: Traditional Instruction (TI), Direct Instruction (DI), and Teaching for Understanding (TfU). The data from the survey in this project point to hybridisation of these models.

Paper 2: Tin Lam Toh *An experienced and competent teacher's instructional practice for normal technical students: A case study*

This paper presents a case of how an experienced and competent teacher engaged mathematics “low-attainers” in the learning of mathematics in a way that was responsive to their learning needs while upholding the ambitious goal of helping them acquire relational understanding of mathematical concepts.

Paper 3: Joseph Boon Wooi Yeo *Imbuement of desired attitudes by experienced and competent Singapore secondary mathematics teachers*

One of the components of the Singapore Pentagonal curricular framework is “Attitude”. This paper presents findings of a survey that point to specific strategies used by Singapore mathematics teacher to imbue positive attitude towards mathematics in their students.

Paper 4: Yew Hoong Leong & Lu Pien Cheng *Singapore mathematics teachers' design of instructional materials*

Case studies based on the data in Phase 1 of the project revealed that the teachers crafted their own instructional materials based on modifications of reference materials. This paper summarises some of the moves teachers adopted when designing instructional materials for their lessons.

Imbuement of desired attitudes by experienced and competent Singapore secondary mathematics teachers

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This paper reports how 30 experienced and competent Singapore secondary mathematics teachers attempted to imbue desired attitudes in their students and some possible factors that might have influenced the teachers' choice of instructional approaches. It was found from the analysis of lesson observations of these teachers that most of those teaching lower-ability students tended to build their students' confidence and perseverance, while those teaching higher-ability students were more inclined to help their students appreciate the relevance of mathematics. Only a minority of the teachers tried to make lessons fun by using mathematics-related resources or telling non-mathematics-related jokes. It was also discovered from the teacher interviews that two factors appeared to influence the teachers' choice of the types of positive attitudes to develop in their students: the abilities of their students and the beliefs of the teachers on what mathematics is.

Most research on the affective domain in mathematics education focuses on finding out students' existing attitudes and their effect on other variables such as test performance (Aiken, 1970; Leder & Forgasz, 2006; McLeod, 1992), and students' and teachers' beliefs (Leder et al., 2002; Maaß & Schlöglmann, 2009; Pepin & Roesken-Winter, 2015). In Singapore, research studies on affective variables also follow the international trend (e.g. Kay, 2003; Ng-Gan, 1987; Tan, 2011) and there are few intervention studies on changing students' attitudes (Yeo, 2018; Yeo et al., 2019).

This paper reports how some mathematics teachers attempted to imbue desired attitudes among their students as part of a programmatic research study on how 30 experienced and competent Singapore teachers enacted the secondary school mathematics curriculum. In the Mathematics Framework for the Singapore school curriculum (Ministry of Education, 1990; 2012), attitudes is one of the main components, consisting of beliefs, interest, appreciation, confidence and perseverance. It is beyond the scope of the research to study whether or how the teachers tried to affirm or change their students' beliefs about mathematics. Instead, this paper will report how most of these 30 teachers attempted to instil confidence in their students, encourage them to persevere, help them to appreciate mathematics and make lessons fun to interest them.

Methodology

In the programmatic research, 30 experienced and competent teachers were videoed teaching a topic for two to three weeks to find out how they implemented the curriculum. For the purpose of this project, an experienced and competent teacher was one who had taught the same course of study for a minimum of five years, and was recognized by the school or school cluster as a competent teacher who had developed an effective approach of teaching mathematics. There are four courses of study in Singapore secondary schools: Integrated Programme (IP), Express, Normal (Academic) (NA) and Normal (Technical) (NT). In general, the abilities of the students decrease from IP to Express to NA and then to NT. For each lesson, two different focus students were also videoed to observe how they responded during the lesson and how they did the mathematics tasks.

Each teacher was also interviewed four times: once before the first lesson, twice at appropriate junctures during the series of lessons and the last time after the last lesson. The purpose of the teacher interviews was to find out more about how and why the teachers had chosen to enact the curriculum in the ways observed during their lessons. At the end of each lesson, the two focus students were also interviewed separately to find out their reactions to the lesson and how much they had learnt. For more details on the data collection, the reader can refer to Toh et al. (2019).

This paper only reports on one aspect of the curriculum enactment: the imbueing of desired attitudes in the students. To analyse the data, the 211 lessons of the 30 teachers were examined to pick up episodes of the teachers trying to cultivate positive attitudes in the classroom. These episodes were then classified according to the sub-components of attitudes in the Mathematics Framework described earlier. The transcripts of the teacher and student interviews were also analysed to triangulate the data obtained from the lesson observations.

Findings and Discussion

Table 1 on the following page shows the number (and percentage) of the 30 teachers in the four courses of study who attempted to imbue desired attitudes in their students using the respective instructional strategies. For each of the first three sub-categories of confidence, perseverance and appreciation, the teachers mainly utilised one instructional approach as shown in the table; while for the last sub-category of interest, the teachers generally employed two pedagogical strategies: using mathematics-related resources and/or telling non-mathematics-related stories or jokes. Some teachers also tried to develop more than one type of desired attitude.

From Table 1, we observed that most of the teachers (26 out of 30, or 86.7%) had tried to imbue desired attitudes in their students. Their foci were mainly in the areas of building students' confidence in doing mathematics by starting with tasks that students could do before progressing to more difficult tasks (20 out of 30, or 66.7%), followed by encouraging the class to persevere and to do well in mathematics (15 out of 30, or 50%). Of lower priorities were helping students appreciate the relevance of mathematics by showing real-life examples and/or applications (11 out of 30, or 36.7%) and making lessons fun to arouse the interest of their students (6 out of 30, or 20%). What was not shown in the table was that slightly more teachers (4 teachers) made lessons interesting by telling non-mathematics-related stories or jokes than those (3 teachers) who did this by using mathematics-related resources, including a teacher who did both.

On closer inspection, across the four courses of study, it is observed that all the teachers teaching the NT and NA courses (which are for lower-ability students) and 8 out of the 10 Express teachers (i.e. 80%) had attempted to develop desired attitudes in their students, but only two of the four IP teachers (i.e. 50%) had done the same. For the NT, NA and Express classes, most of the teachers focused on building students' confidence and encouraging the class to persevere, followed by helping students appreciate the relevance of mathematics and making lessons interesting. But for the IP course of study (which is for higher-ability students), the focus of the teachers was more on helping students appreciate the relevance of mathematics. In fact, only one of the four IP teachers had tried to encourage her class to persevere on only one occasion in all her seven one-hour lessons that were observed over more than two weeks, i.e. encouraging their students did not seem to be a high priority among IP teachers.

Table 1
Instructional Strategies for Imbuing Desired Attitudes in Students

Instructional Approach	Number (and Percentage) of Teachers				
	IP (<i>n</i> = 4)	EX (<i>n</i> = 10)	NA (<i>n</i> = 8)	NT (<i>n</i> = 8)	Total (<i>N</i> = 30)
Building students' confidence in doing mathematics by starting with tasks that students can do before progressing to more difficult tasks	0 (0%)	6 (60%)	8 (100%)	6 (75%)	20 (66.7%)
Encouraging the class to persevere and to do well in mathematics.	1 (25%)	5 (50%)	5 (62.5%)	4 (50%)	15 (50%)
Helping students appreciate the relevance of mathematics by showing real-life examples and/or applications	2 (50%)	2 (20%)	4 (50%)	3 (37.5%)	11 (36.7%)
Making lessons interesting by using mathematics-related resources and/or telling non-mathematics-related stories	0 (0%)	2 (20%)	2 (25%)	2 (25%)	6 (20%)
Attempting to imbue any desired attitudes in students	2 (50%)	8 (80%)	8 (100%)	8 (100%)	26 (86.7%)

From the above analysis, it seems that one factor that might have influenced the teachers' instructional strategies in imbuing what sub-category of desired attitudes is the abilities of the students whom they were teaching in their respective course of study: for lower-ability students, their teachers focused on building their confidence and encouraging them to persevere, but for higher-ability students, their teachers were more inclined to help them appreciate the relevance of mathematics. This is further confirmed by interviews with the teachers. For example, a teacher said that her type of students needed motivation to solve more difficult mathematical problems and so she used an amusing video to provide the link to real life and to entice her class to solve the problems. The following shows part of a transcript of an interview with the teacher.

Interviewer: So what is your purpose for showing them this video?

Teacher: It's actually to entice them to be interested in doing mathematics because ... when you keep on practising and they don't see how it can be linked, it is very difficult. So we want to see, eh, ancient times people are already using Pythagoras' theorem ... Because, my class, I think they need this kind of motivation, because some of them will fall into a world of their own very easily. So we wanted them to ... entice them to this kind of thing ... so after this, what they will do is, the king [from the video] has a series of problems, so they will try to solve the king's problems by Pythagoras' theorem.

Another factor that might have influenced the teachers' instructional approaches in cultivating which kind of positive attitudes is the beliefs of the teachers. For example, a teacher encouraged his students to try to score at least a few marks for a difficult exam-type question because he revealed during an interview that he believed that mathematics was

about resilience and so he was attempting to convince his class not to give up on such examination questions.

Conclusion

The study has shown how some experienced and competent teachers in Singapore attempted to imbue desired attitudes in their students. They focused mainly on building their lower-ability students' confidence and perseverance, while helping higher-ability students appreciate the relevance of mathematics. The least priority among the teachers was making lessons interesting. An implication for local teachers is maybe they should emulate the examples of the experienced and competent teachers in developing confidence, perseverance and appreciation in their students (if they are not already doing so), but at the same time, they could perhaps pay more attention to arousing in their students interest in mathematics. A possible area for future research is to study whether the students had developed the desired attitudes under the instructional strategies adopted by the teachers.

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