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.

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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.

Models of mathematics teaching practice in Singapore secondary schools

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A model of instruction is a set of strategies that guide teachers in their instructional practice. The purpose of this paper is to dispel the myth that mathematics teaching in Singapore schools is all about drill and practice, as perceived of many Asian systems. This paper draws on data of a large project that examined the enactment of school mathematics curriculum in Singapore secondary schools. Based on the teaching practices of 30 experienced and competent teachers, a survey was constructed and administered to 677 teachers. The data from the survey showed that teachers go well beyond traditional forms of instruction in their teaching practices in Singapore secondary schools.

Leung (2001) noted that in East Asian mathematics classrooms

> Instruction is very much teacher dominated and student involvement minimal. … [Teaching is] usually conducted in whole group settings, with relatively large class sizes. … [There is] virtually no group work or activities, and memorization of mathematics is stressed … [and] students are required to learn by rote. … [Students are] required to engage in ample practice of mathematical skills, mostly without thorough understanding. (Leung, 2001, pp. 35–36).

Hogan et al. (2013) examined the instructional practices of Grade 9 mathematics teachers and found that several models of instruction were prevalent in the practices. All of which had the goal of mastery and examination preparation. In a synthesis of past mathematics classroom studies done in Singapore, Kaur (2017) conjectured that instructional practices for mathematics in Singapore classrooms, based on the data of the study by Hogan et al. (2013) and the Learners Perspective Study carried out in Singapore (Kaur, 2009), cannot be considered either Eastern or Western but a coherent combination of both. Basis of the claim is that: i) Traditional Instruction (TI) provides the foundation of the instructional order, and ii) Direct Instruction (DI) builds on TI practices and extends and refines the instructional repertoire. While Teaching for Understanding/ Co-regulated Learning Strategies (TfU/CRLS) practices build on TI and DI practices and extend the instructional repertoire even further in ways that focus on developing student understanding and student-directed learning. The study reported in this paper further illuminates models of teaching practices of mathematics teachers in Singapore secondary schools.

The Study

The study reported in this paper is part of a larger project, details of which are available elsewhere (Kaur et al., 2018; Toh et al., 2019). A study of mathematics lessons enacted by 30 experienced and competent mathematics teachers in Singapore secondary schools revealed that teacher and student actions from three main models of instruction were guiding teachers in their instructional practice. We elaborate the models and provide examples of teacher and student actions that were observed in the lessons of the experienced and competent teachers (which are marked *) as well as those that were not but were included in the survey. For actions that are marked * we also indicate the respective courses of study which are Integrated Programme (IP), Express Course (EX), Normal (Academic) Course

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(NA) and Normal (Technical) Course (NT) where the actions were observed. The IP is for the mathematically able students and the NT is for the least able ones.

Traditional Instruction (TI)

A method of instruction that is teacher-centred, rather than learner-centred, in which the focus is on rote-learning and memorisation. In the context of Asian classrooms it is often associated with drill and practice (Biggs & Watkins, 2001; Hogan et al., 2013; Leung, 2006). There were altogether 13 TI teacher actions, and examples of two such actions are as follows:

Teacher –

- *asking students direct questions to stimulate students' recall of past knowledge / check for understanding of concepts being developed in the lesson (EX, NA)
- *providing students with sufficient questions from textbooks / workbooks / other sources to practise so as to develop procedural fluency (EX, NA, NT)

Direct Instruction (DI)

A method of instruction that involves an explicit step-by-step strategy, often teacher-centred, with checks for mastery of procedural or conceptual knowledge (Hattie, 2003; Hogan et al., 2013; Good & Brophy, 2003). There were altogether nine teacher actions and two student actions and examples of two each are as follows:

Teacher –

- *using the "I do, We do, You do" strategy, i.e.
  - Demonstrating how to apply a concept / carry out a skill on the board [I do]
  - Demonstrating again the same using another similar example but with inputs from students [We do]
  - Asking the students to do a similar question by themselves [You do] (EX, NA, NT)
- *explaining what exemplary solutions of mathematics problems must contain (logical steps and clear statements and / or how marks are given for such work during examinations) (IP, EX, NA)

Students –

- *asking questions when they do not understand (IP, EX, NA, NT)
- *practising a similar problem after the teacher has shown them how to do a similar one on the board (IP, EX, NA, NT)

Teaching for Understanding (TfU)

A method of instruction that places student learning at the core. Teacher facilitates, monitors and regulates student learning through student-centred approaches (Hogan et al., 2013; Good & Brophy, 2003; Perkins, 1993). There were 13 teacher actions and 15 student actions, and examples of two each are as follows:

Teacher –

- *focusing on mathematical vocabulary (such as equations, expressions) to help students build mathematical concepts (IP, EX, NA, NT)
- *providing collective feedback to whole class for common mistakes and misconceptions related to in-class work and homework (IP, EX, NA, NT)

Students –

- *explaining how their solutions or how their answers are obtained (IP, EX, NA, NT)
- *discussing and helping each other while doing individual seatwork (IP, EX, NA, NT)

The Survey

The survey had three parts. The first part had 60 items (36 describing teacher actions and another 24 describing student actions). Amongst these items were the seven items on TI, 11 items on DI and 28 items on TfU. In the survey, teachers were asked to reflect on their lessons for a course (IP, EX, NA or NT) they were teaching, and respond to the items indicating the frequency of their actions on a Likert Scale of 1 (Never/Rarely) to 4 (Mostly/Always). 691 teachers completed the survey. In the preliminary screening of the data, some responses were removed as they did not meet the requirements of the survey. The data of 677 teachers were used for subsequent analyses. Forty percent of the teachers were male while 60 % were female and this was representative of the demographic of the teacher population in secondary schools which were 36 % males and 64 % females (MOE, 2018). In addition, the representation by course of study, almost 65% for the IP and EX, and 35% for the NA and NT courses was also coherent with the demographic of the student population in secondary schools which was 64% and 36% respectively for the IP and EX and NA and NT courses (MOE, 2018). Forty-five percent of the teachers had more than three but less than 10 years of mathematics teaching experience while the rest 55% had more than 10 years of the same experience.

What models of instruction guide mathematics teaching in the classrooms of mathematics teachers in Singapore secondary schools, in general?

Table 1
Means of the three models of instruction

Course of Study	Mean+ Model of Instruction		
	TI	DI	TfU
All (n=677)	2.78	3.11	2.86
Integrated Programme (IP) (n=58)	2.42	3.07	3.00
Express (EX) (n=380)	2.78	3.10	2.88
Normal (Academic) (NA) (n=151)	2.81	3.10	2.77
Normal (Technical) (NT) (n=88)	2.94	3.17	2.85

[+]maximum = 4; minimum = 1.

Table 1 shows that teachers appear to draw on teaching moves from all the three models of instruction, though with differing emphasis to enact their lessons. Direct Instruction appears to be the dominant model that teachers draw on in all the four courses of study. In the NA and NT classes, Direct Instruction and Traditional Instruction are apparently more prevalent whilst in the IP and EX classes Direct Instruction and Teaching for Understanding are apparently more prevalent. We next examined the survey items for each course of study that had a mean greater than 3 and a standard deviation of less than or equal to 0.7. The following teaching/learning actions were found to be common across all the four courses of study.

- Teacher providing students with sufficient questions from textbooks / workbooks / other sources to practise so as to develop procedural fluency
- Students asking questions when they do not understand
- Teacher walking around the class and providing students with between-desk instruction (i.e. help them with their difficulties) when they are doing their work at their desks
- Teacher walking around the class noting student work that teacher would draw on to provide the class feedback during whole class review
- Teacher only progressing to the next objective of the lesson when he/she is confident that students have grasped the one before
- Teacher providing feedback to individuals for in-class work and homework to serve as information and diagnosis so that students can correct their errors and improve
- Teacher providing collective feedback to whole class for common mistakes and misconceptions related to in-class work and homework
- Teacher focusing on mathematical vocabulary (such as factorise, solve) to help students adopt the correct skills needed to work on mathematical tasks
- Students explaining how their solutions or their answers are obtained

We conclude that the model of instruction that mathematics teachers in Singapore secondary schools adopt is a hybrid one comprising TI, DI and TfU. This finding lends to strengthen our earlier conjecture that mathematics instruction in Singapore secondary schools is neither Eastern nor Western but a coherent combination of both, i.e. a hybridisation of TI, DI and TfU.

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