Mathematics Education Research in Singapore

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Outline

- **Introduction to Education Research in Singapore**
- **Education Research in Singapore**
- **An Example of a Mathematics Education Research**
- **General trends**

Introduction

- **What is the underlying objective of education research in Singapore?** **Summarized by the closing address by the Singapore Deputy Prime Minister Mr Teo Chee Hean in his visit to National Institute of Education (NIE):**
- **Important to understand the reasons why Singapore has performed well in various areas of education**
- **Such an understanding will better adapt the nation to the constantly changing world where the conditions will not be the same.**
- **This will ensure high quality of education in Singapore**

Introduction

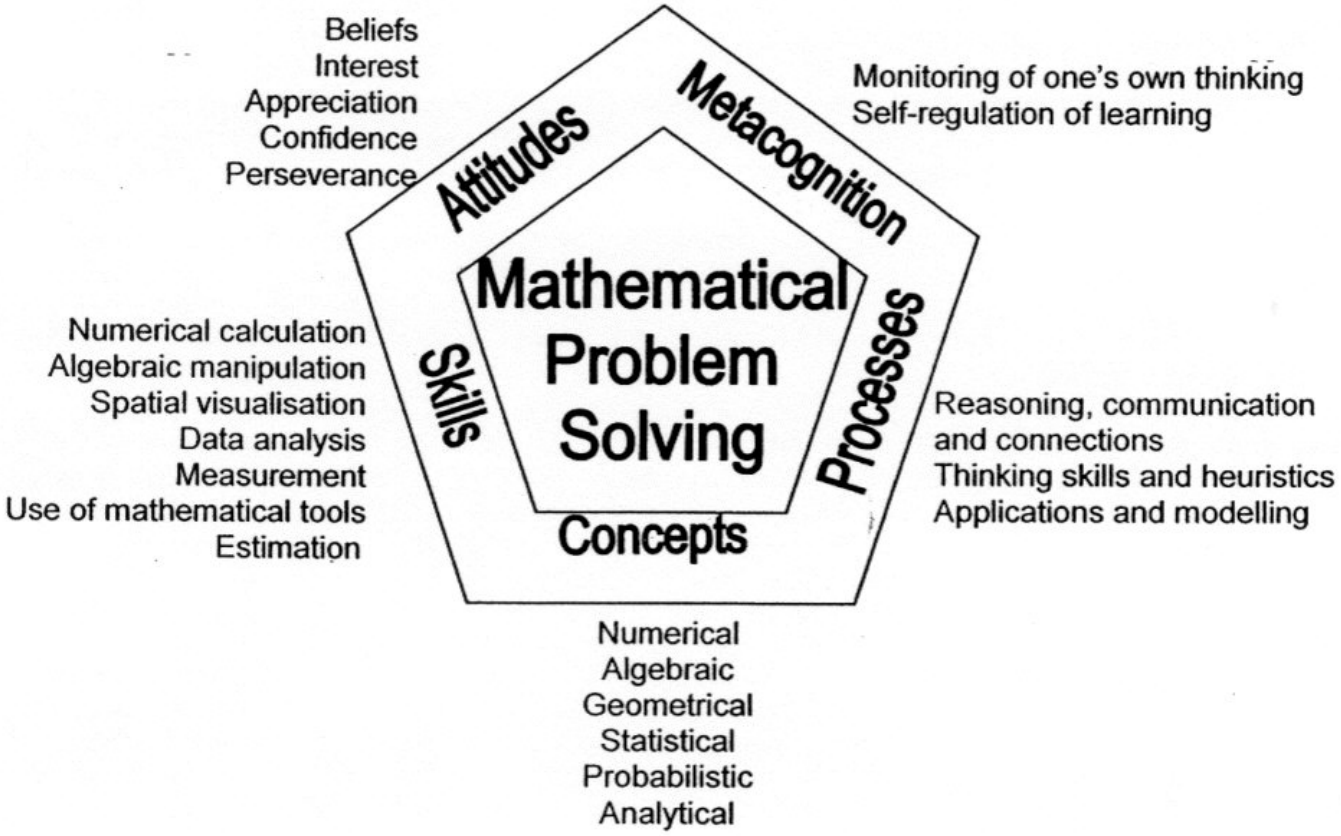
- **Researchers in Singapore are generally self-critical in appraising own progress in education.**
- **Looking for areas that need to be addressed urgently (e.g. low progress learners in mathematics and science)**
- **Strive for even better performance (e.g. mathematical reasoning and problem solving)**
- **Explore new areas in anticipation of the future (e.g. computational thinking and coding)**

Introduction

- **Problem Solving is the heart of the Singapore Mathematics Curriculum.**
- **Not surprising that there are much research that centres around mathematical problem solving in Singapore.**
- **An estimated breakdown of the number of research papers published on problem solving from 2001 to 2011 is as shown below:**

Heuristics and Model Drawing (13); Open-ended real world problem (11); Cognition and Sense Making (5); Metacognition (5); Affect (5); ICT (5); Problem Solving Curriculum (10); Others (posing, language proficiency) (8)

Introduction



An Example of Math Ed Research

- **Singapore has performed well in international comparative studies in Mathematic & Science. However, few observations stirred researchers' interest in mathematical problem solving**
  - **Singapore students have weaker performance in solving unfamiliar problems in TIMSS (Kaur, 2009).**
  - **Teachers "routinize" problems into exercises for students; problem solving processes have not been emphasized in classrooms (Fan & Zhu, 2007).**
  - **Problem solving is not directly assessed in the curriculum.**
  - **Anecdotal evidence shows that classroom teachers reduce problem solving to the teaching of "heuristics" for various mathematical problems.**

An Example of Math Ed Research

- **That body of research [on problem solving] … was robust and has stood the test of time … The theory had been worked out; all that needed to be done was the (*hard and unglamorous*) work of following through in practical terms. (Schoenfeld, 2007)**

- **Research on problem solving – not so much focus on theory building, but more of translating theory to practice in the mathematics classrooms.**

An Example of Math Ed Research

- **Build on a Science Practical paradigm to teach mathematical problem solving.**
- **Emphasize on the processes of problem solving.**
- **Use a "mathematics practical worksheet" to scaffold students' problem solving process.**
- **Design an assessment scheme that assesses not only the product of problem solving, but also the processes of problem solving.**
- **Use a modified form of lesson study to build teacher capacity in teaching problem solving.**

An Example of Math Ed Research

- **Phase 1: Teacher Training**
- **Phase 2: Researcher conducts experimental lesson on students; Teachers observe the experimental research lessons.**
- **Phase 3: Teachers conduct lessons on their students; Researchers observe the lessons.**
- **Identifying any fine-tuning needed.**
- **The process is one of "iterating" towards a package that is suitable for individual schools.**

An Example of Math Ed Research

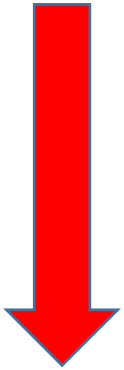
Design Experiment

- **Multiple ways of data collection (classroom observation, artefacts, interview, focus group etc.)**
- **Can be adaptable so long as the fundamental parameters are unchanged.**

An Example of Math Ed Research

Begin with examining the CURRICULUM

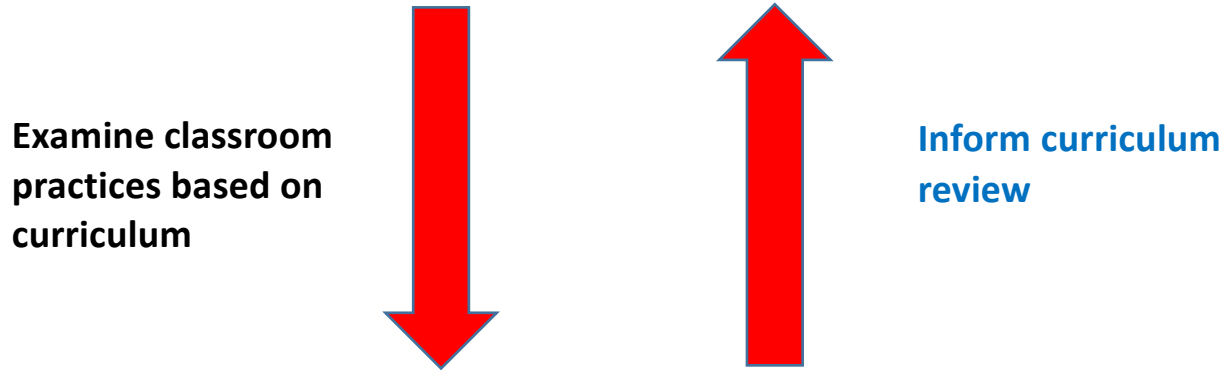
Examine classroom practices based on curriculum



Examine how the curriculum is enacted in the classrooms, i.e. the TEACHING AND LEARNING PRACTICES

An Example of Math Ed Research

Begin with examining the CURRICULUM



Examine how the curriculum is enacted in the classrooms, i.e. the TEACHING AND LEARNING PRACTICES

Problem Solving should be taught to the true spirit in the curriculum. The Ministry of Education has adopted some of the practices in designing one of the higher level H3 course.

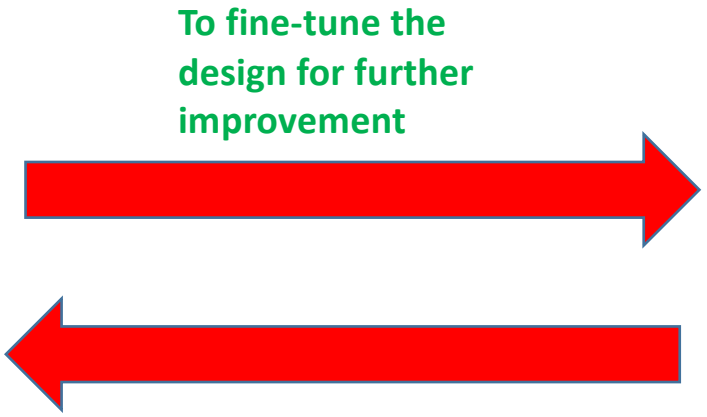
An Example of Math Ed Research

Teacher Professional Development and Pre-service teacher education

To assist sustainability of innovative practice in schools and to gain buy-in at the preservice education level

An Example of Math Ed Research

Teacher Professional Development and Pre-service teacher education



An Example of Math Ed Research

- **The first research project on Mathematical Problem Solving has led to a series of studies on Mathematical Problem Solving at the Undergraduate Level.**
- **Mathematical Problem Solving approach has become a permanent feature in the pre-service teacher education programme.**
- **MPS has also resulted in several in-service courses that are offered for teachers as content and pedagogy upgrading.**

Second Example of Math Ed Research

- **Let us look at another example of a large scale research project recently conducted in Singapore by a group of academic staff from the Singapore National Institute of Education.**
  - **National Mathematics curriculum is reviewed once every five years. Curriculum review leads to research on the efficacy of the new curriculum which springs off to further inform the next curriculum review.**

Second Example of Math Ed Research

- **New curriculum was rolled out in 2013.**
- **The objective of the enactment project is to study how experienced teachers enacted the mathematics curriculum prescribed by the Ministry of Education.**
- **Study carried out in 2016 – 2018.**

Second Example of Math Ed Research

- **Teachers focus more on procedural knowledge than conceptual knowledge and only engage students in domain-specific knowledge practice ... Procedural learning support is evident as teachers often help students with "how to do steps".**
- **Students are engaged in doing performative tasks (77.3%) more than knowledge building tasks (22.7%)…**
- **The dominant performative orientation of pedagogical practice in Singapore may explain Singapore's stellar performance in international studies…**

Hogan et al., 2013a, 2013b, 2013c

Second Example of Math Ed Research

- **Does not inform us how the competent teachers perform c.f. the general teacher population.**
- **It is not possible to infer how the "performative orientation" has contributed to Singapore students' performance in PISA studies.**

Second Example of Math Ed Research

- **The study consists of two phases:**
- **Phase 1 (video segment) – documents the pedagogy of 30 experienced mathematics teachers using complementary accounts methodology (Clark, 1998; 2001)**

Second Example of Math Ed Research

- **Phase 2 (survey segment): Data was collected from 690 Singapore mathematics teachers through self-reporting questionnaire on how prevalence the practices of the experienced teachers are.**

Second Example of Math Ed Research

- **A deeper lens into the classroom study of the 30 experienced teachers shows that the Singapore mathematics classroom is not typically drill-and-practice.**
- **A microscopic analysis of the classroom episode shows that there is a repeated cycle of DSR (Development-Seatwork-Review). After each cycle of DSR, the students' knowledge of the mathematical concepts is further reinforced.**
- **The DSR cycle is almost like the DNA of the Singapore mathematics classroom.**

Second Example of Math Ed Research

- **The research is now analyzing how prevalent the practices in the 30 experienced mathematics teachers are among all the teachers in Singapore (through the data collected from 690 Singapore teachers).**
- **Next step: teacher professional development to reach out to the entire Singapore mathematics teacher community.**
- **Further step: Provide informed decision for the Singapore Ministry of Education for the next curriculum review.**

Third Example of Math Ed Research

- **Despite Singapore has done reasonably well in international comparative studies such as TIMSS and PISA, there is a long "tail" of low achievers, compared to many other east Asian countries.**
- **Ministry of Education started the ICAN protect to support teacher professional development.**
- **Academic Staff in the Singapore National Institute of Education (NIE) are engaged to support the Ministry's effort in evaluating the ICAN for low attaining students.**

Third Example of Math Ed Research

- **Other Academic Staff in the National Institute of Education attempted different classroom practices to address the learning needs of the low achieving students.**
  - **Concrete-Pictorial-Abstract (CPA) approach in teaching mathematics, use of concrete manipulatives to help students learn abstract mathematical concepts;**
  - **A totally radical approach in learning mathematics using communication theory (e.g. use of comics in teaching and learning mathematics).**

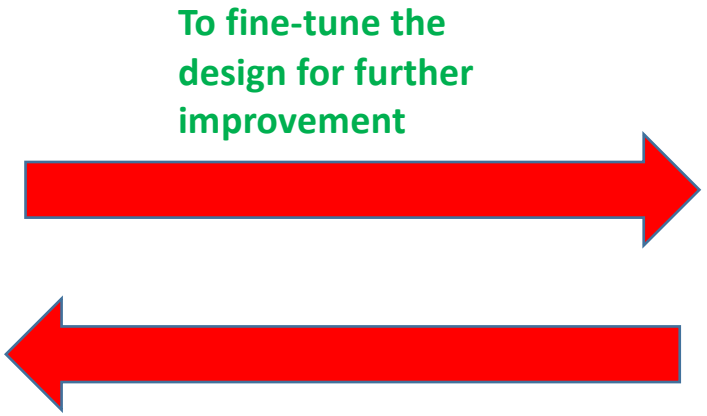
Third Example of Math Ed Research

Teacher Professional Development and Pre-service teacher education

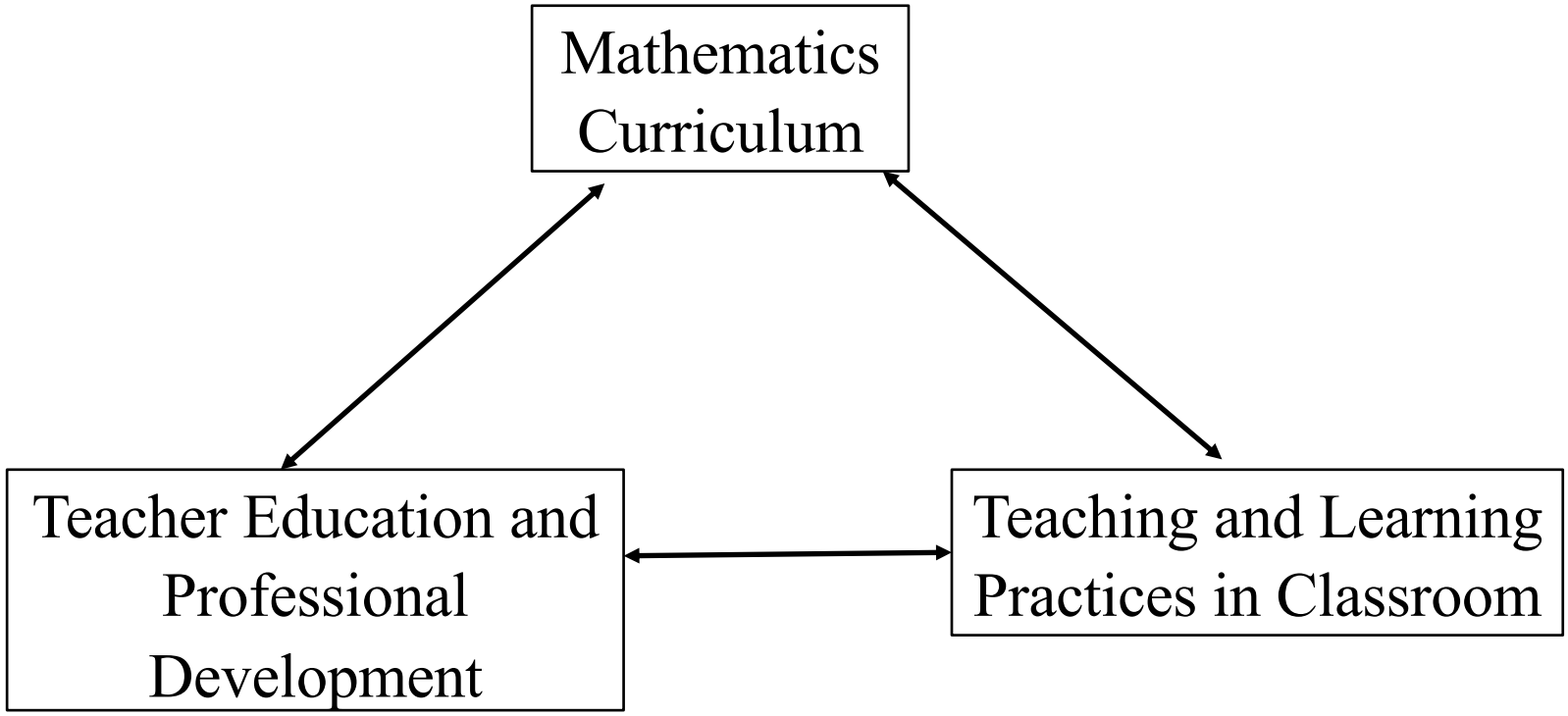
Started off as classroom practices. To create buy-in and sustainability, introduce to teacher professional development

Third Example of Math Ed Research

Teacher Professional Development and Pre-service teacher education



General Trend in Mathematics Education Research in Singapore



What next in Math Education Research in Singapore?

- **Big Ideas in Mathematics**

What next in Math Education Research in Singapore?

- **Computational Thinking and Coding**

What next in Math Education Research in Singapore?

- **Research in Support of the Movement of the Singapore Ministry of Education.**

General Trend in Mathematics Education Research in Singapore

- **Research that impact schools and inform curriculum review is the trend in Singapore Education Research.**