MY INSIDER VIEW OF THE SINGAPORE MATHEMATICS CURRICULUM

A/P CHOY Ban Heng

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NIE NATIONAL INSTITUTE OF EDUCATION SINGAPORE
An Institute of
NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

INTRODUCTION

A bit about myself...

(2000 to 2009)	Mathematics teacher – High School Head, Special Projects
(2009 to 2011)	Curriculum Policy Officer, MOE
(2015 till present)	Mathematics Education Researcher

A bit about Singapore ...

Small country (~720 square km); no natural resources except people
Done relatively well in international benchmark assessments such as TIMSS, PISA, and PIRLS.

Choy, B. H., & Dindyal, J. (2024). "Chapter 39: The Singapore mathematics curriculum: influences and confluences". In Research Handbook on Curriculum and Education. Cheltenham, UK: Edward Elgar Publishing. Retrieved Sep 3, 2024, from https://doi.org/10.4337/9781802208542.00048

WHAT'S THE SECRET?

Tan et al. (2021a) describe **Singapore teachers** and the **Singapore curriculum** as the key drivers behind the consistent performance and improvement of the Singapore education system.

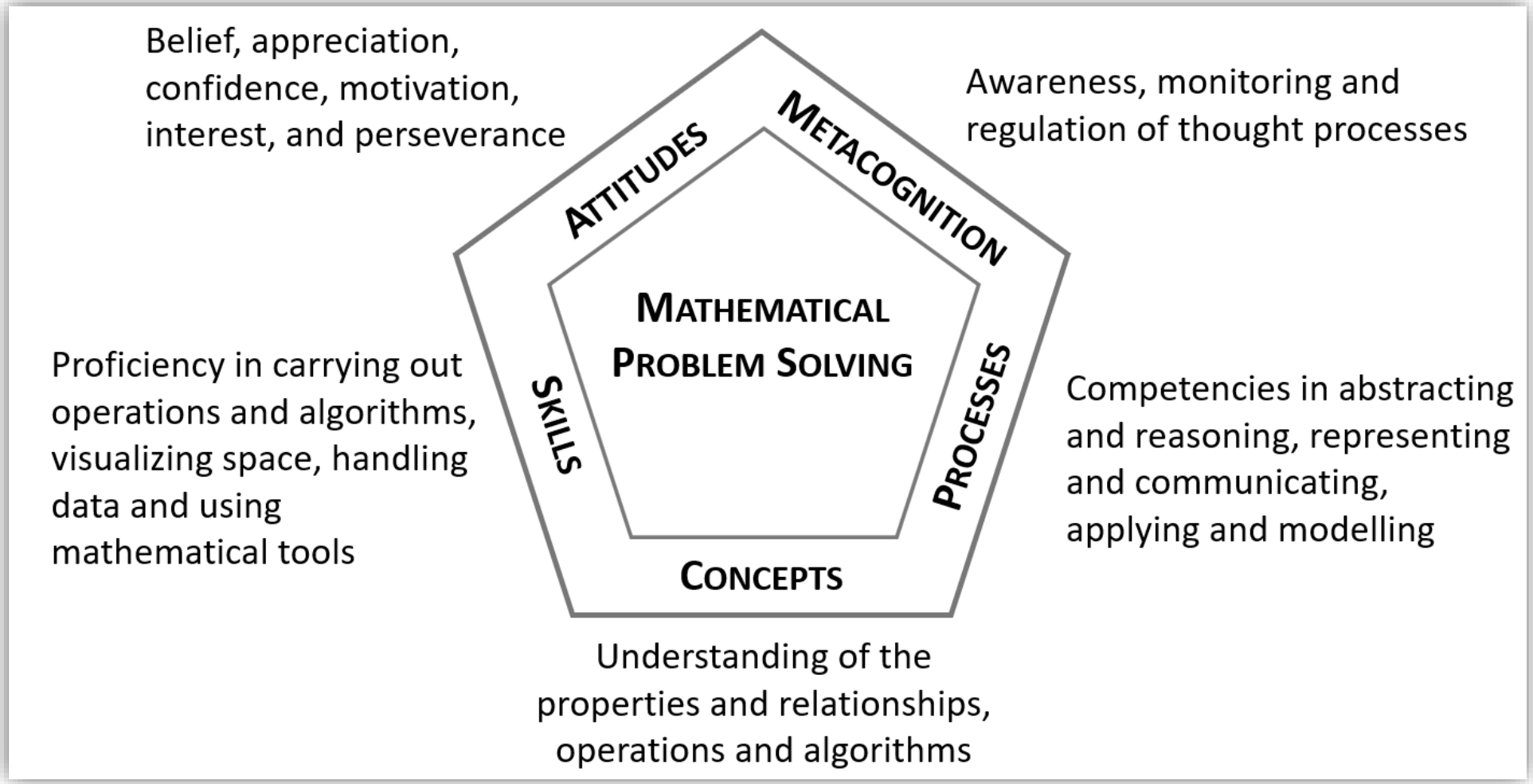
A USEFUL IDEA

A mathematics curriculum is not simply a collection of documents highlighting what and why mathematics should be taught to students in schools (Choy & Dindyal, 2024, p. 534).

Garden (1987) highlighted three key conceptualisations of curriculum: **intended**, **implemented**, and **attained**.

A RACETRACK METAPHOR (WONG, 2015)

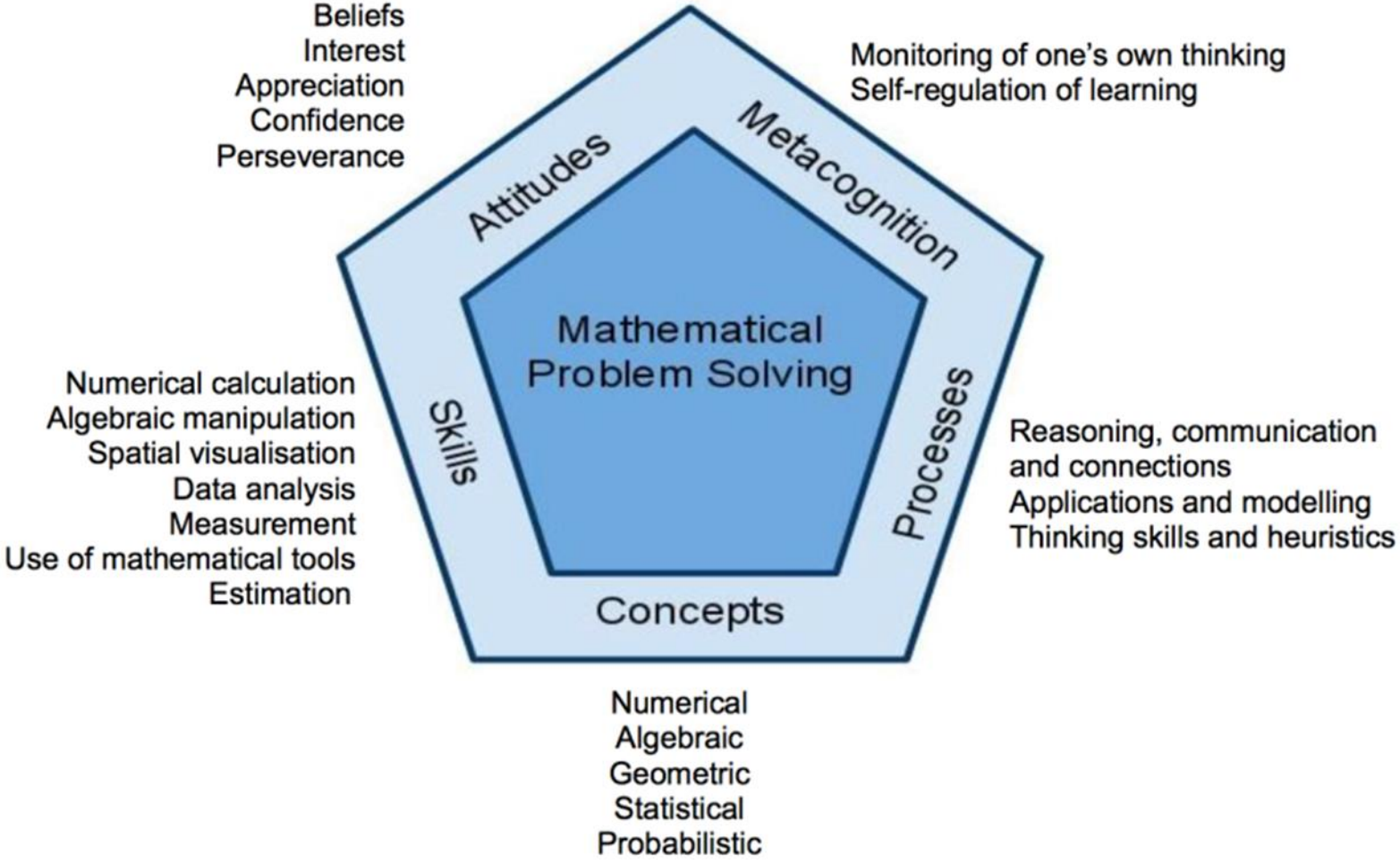
THE SG MATHEMATICS CURRICULUM FRAMEWORK



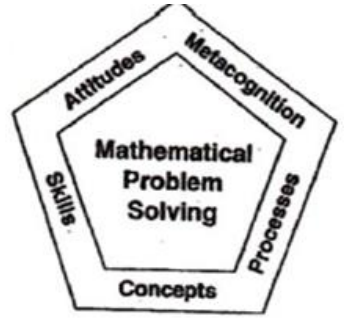
THE IDEA BEHIND...

- Students' development of **mathematical problem-solving** competency is supported by their understanding of key **concepts** in mathematics and proficiency in carrying out a wide range of mathematical **skills**.
- Besides domain-specific mathematical skills, more generic mathematical **processes** such as abstracting, reasoning, representing, communicating, applying, and modelling are also foundational to the central goal of mathematical problem solving.
- In addition, students are expected to develop their **metacognition** – being aware, monitoring and regulating one's thinking processes – and nurture positive beliefs, **attitudes**, and dispositions towards mathematics (Lee et al., 2019; Ministry of Education-Singapore, 2012b, 2019a; Soh, 2008).

THE ‘PENTAGON’ FRAMEWORK (1990 – 2020)



EVOLUTION OF THE FRAMEWORK



Primary Goal: Mathematical Problem Solving

Component	1991- 2000	2001- 2006	2007- 2012	2013 - beyond
Concepts	- Numerical - Geometrical - Algebraic - Statistical	- Numerical - Geometrical - Algebraic - Statistical	- Numerical - Geometrical - Algebraic - Statistical - Probabilistic - Analytical	- Numerical - Algebraic - Geometrical - Statistical - Probabilistic - Analytical
Skills	- Estimation & Approximation - Mental calculation - Communication - Use of mathematical tools - Arithmetic manipulation - Algebraic manipulation - Handling data	- Estimation & Approximation - Mental calculation - Communication - Use of mathematical tools - Arithmetic manipulation - Algebraic manipulation - Handling data	- Numerical calculation - Algebraic manipulation - Spatial visualization - Data analysis - Measurement - Use of mathematical tools - Estimation	- Numerical calculation - Algebraic manipulation - Spatial visualization - Data analysis - Measurement - Use of mathematical tools - Estimation
Attitudes	- Appreciation - Interest - Confidence	- Appreciation - Interest - Confidence - Perseverance	- Beliefs - Appreciation - Interest - Confidence - Perseverance	- Beliefs - Interest - Appreciation - Confidence - Perseverance
Meta cognition	- Monitoring one's own thinking	- Monitoring one's own thinking	- Monitoring of one's own thinking - Self-regulation of learning	- Monitoring of one's own thinking - Self-regulation of learning
Processes	- Heuristics - Deductive reasoning - Inductive reasoning	- Heuristics - Thinking Skills	- Reasoning, communication and connections - Applications and modeling - Heuristics - Thinking Skills	- Reasoning, communication and connections - Applications and modeling - Thinking skills and heuristics

Kaur, B. (2019). Evolution of Singapore's School Mathematics Curriculum. In C. P. Vistro-Yu & T. L. Toh (Eds.), School Mathematics Curricula: Asian Perspectives and Glimpses of Reform (pp. 21-37). Springer Singapore. https://doi.org/10.1007/978-981-13-6312-2_2

SOME REFLECTIONS

- **Stable** framework since 1990s
- **Common language** for teachers, teacher leaders, policy makers, researchers, and other stakeholders
- New initiatives are introduced by **keeping an eye on the SMCF**
- **SMCF** guides how new initiatives are communicated and implemented.
- **National examinations are adjusted** to reflect the new initiatives and changes in emphases.
- **MOE provides schools** with resources, professional development, and some autonomy to implement these ideas in different ways, optimising the **alignment between the implemented and intended curricula**

A PRAGMATIC STANCE

Given that Singapore places a high premium on education and there is a high expectation for every child, which is the nation's only resource, to do their best in education, it is not surprising that Singapore's **pragmatic approach** to teaching and learning has **enabled the best ideas from all over the world to be adapted for its use.**
(Choy & Dindyal, 2024, p. 537)

NOT JUST A COPY... BUT THINGS WORK BECAUSE...

- The Ministry of Education (MOE) is largely made up of teachers
- The National Institute of Education (NIE) is Singapore's only teacher training institute
- The Academy of Singapore Teachers (AST), which is part of MOE, is responsible for professional development of teachers
- Strong tripartite collaboration between MOE, NIE, and AST

Singapore has adapted these borrowed best practices in ways that are tailored to the specific local influences, such as traditions, politics, and cultures.

REFLECTIONS ON INTENDED CURRICULUM

Problem Solving

- Cockcroft Report (Cockcroft, 1982), NTCM, Pólya (1945) and Schoenfeld (1985)
- Expanded the idea of a problem to include routine exercises or typical problems (Choy & Dindyal, 2021; Wong, 2015)

Problems in Real World Contexts (PRWC)

- Realistic Mathematics Education (Van Den Heuvel-Panhuizen, 2003), using real-world problems for teaching (Galbraith, 2006), and math modelling
- Our notion of PRWC is scoped more as a closed mathematics question about a real-world problem (Yeo et al., 2018)

Other Examples

- Teaching towards big ideas

TIMELY CHANGE TIMELESS CONSTANT (NG, 2017)

Even when there is a need to be responsive to the ever-changing world, the intended curriculum is revised while keeping the SMCF as a constant (Choy & Dindyal, 2024).

REFLECTIONS ON IMPLEMENTED CURRICULUM

- Not simply “traditional” or “reform-based inquiry”.
- Our Teachers create **high-quality mathematical learning experiences** to honour **both conceptual understanding and procedural fluency** (Choy & Dindyal, 2021; Kaur et al., 2019; Leong & Kaur, 2019)
- Textbooks as **mediators** of intended and implemented curricula. Suggested approaches such as Model Method and C-P-A are embedded. Concrete examples of how new initiatives can be implemented are also highlighted in the textbooks.
- **Gradual** and systematic implementation of revised intended curricula
- Support given by MOE, NIE, and AST
- Teachers are given time to make sense of the intended curriculum and work collaboratively to implement these new ideas.

What was implemented is not **simply a copy** of the ideas found in Bruner (1966) or Skemp (1978). Instead, there was a deliberate attempt at **balancing the influences** from these ideas with the contextual influences of Singapore's educational landscape. There is a **clear expectation** that teachers should also ensure mastery of basic concepts and skills through activity-based learning, inquiry-based learning, and direct instruction – a clear statement that **effective teaching can take a variety of forms** (Choy & Dindyal, 2024).

REFLECTIONS ON ATTAINED CURRICULUM

- A commonly held perception that Singapore's mathematics education is pretty much focused on **high-stakes** examinations?
- Our examinations do not simply test students on their procedural fluency, but they are **designed to assess whether students understand and apply mathematical concepts to different problems in different contexts**.
- "Porous" streaming versus multiple pathways to success.
- Compassionate meritocracy (Ng, 2017)
- Shift to de-emphasise examinations, more focused on formative assessments (Black & Wiliam, 1998)
- Streaming replaced by **full subject-based banding** (https://www.moe.gov.sg/microsites/psle-fsbb/full-subject-based-banding/main.html)
- Joy of learning (Learn for Life: Remaking Pathways)

MORE REFLECTIONS

- Avoided extreme positions (traditional versus reformed) by characterizing excellence in mathematics education as the **confluence of intended curriculum, implemented curriculum, and attained curriculum** (Choy, 2021; Wong, 2015)
- The actions of the policy makers, school leaders, teachers, students, parents, mathematics educators, and other stakeholders '**flow together towards a clearly articulated vision of mathematics education**' (Choy, 2021, p. 54).
- The SMCF plays a **pivotal** role as the 'invisible hand'.
- New initiatives **build on** the existing foundations of the framework and are assimilated into the curriculum as shifts in emphasis instead of reform.
- **Professional development** as the **key** to ensure **alignment** between the three curricula

NO ONE-SIZE-FIT-ALL SOLUTION

4 paradoxes

Timely changes Timeless Constants

Compassionate meritocracy

Centralised Decentralisation

Teach Less Learn More

(Ng, 2017)

QUESTIONS?

CHOY Ban Heng

banheng.choy@nie.edu.sg


thank you

What we are alike and what we are not?

-What Japan can learn from Singaporean education?-

Hiroki Ishizaka
Professor
Naruto University of Education

Visiting Scholar
National Institute of Education

Outline

- **Common characteristics between Singapore (SG) and Japan (JP)**
- **Different characteristics between them**
- **International Cooperation of Singapore**
- **Any lessons for International Cooperation of Japan**

Common characteristics of mathematics education between SG & JP

Common characteristics

- Purpose
- Contents
- Structured Problem Solving(Japan) ≒ Polya's four-step problem solving (Singapore)
- CPA
- Meta-cognition (reflection)
- Activity-based Learning
- Inquiry-based Learning
- Mathematical Modeling
- Help students to use mathematical strategies
- Mixed proficiency classroom (Mastery of contents done all together)

Purpose of mathematics learning

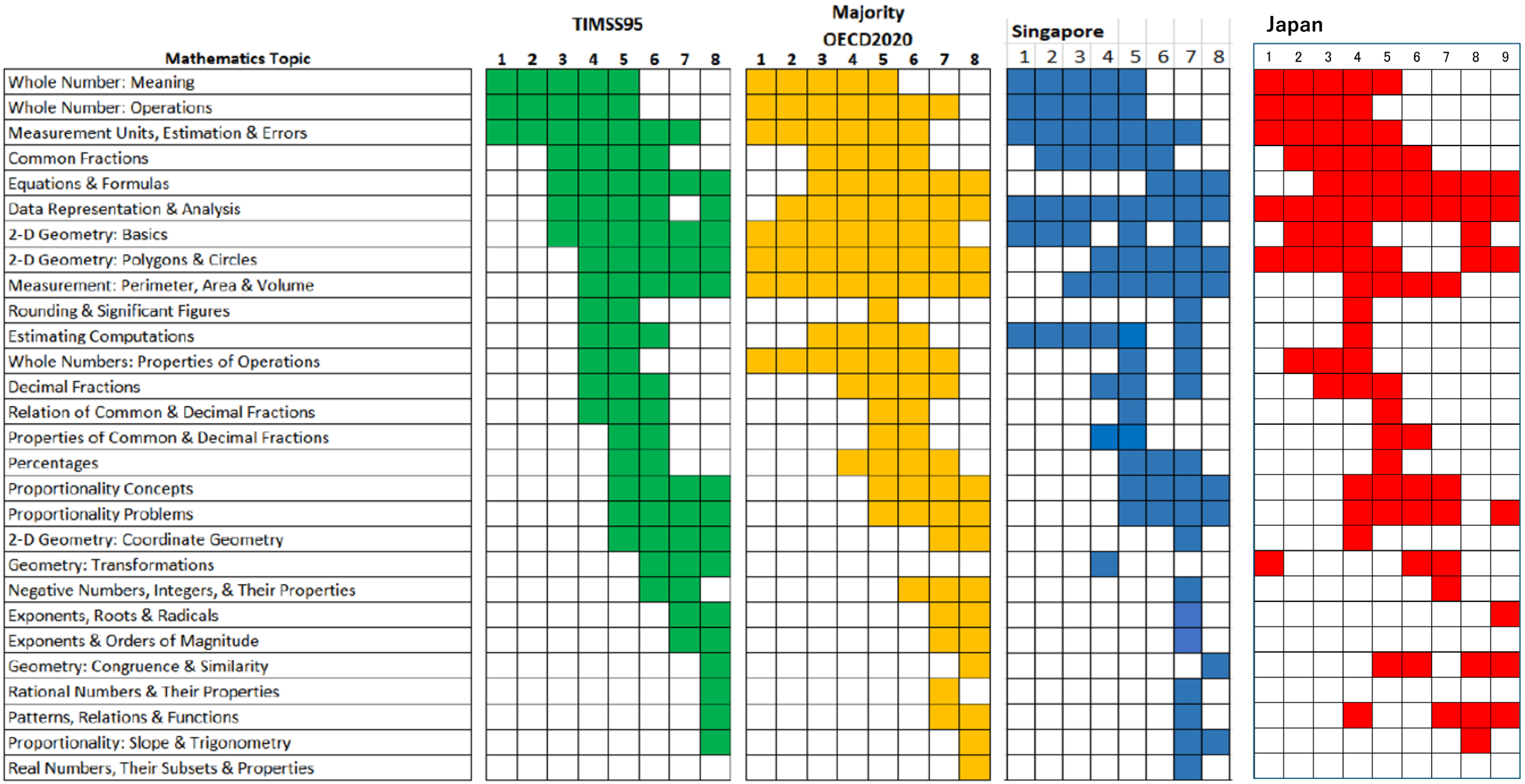
Enhance conceptual understanding through use of the **Concrete-Pictorial-Abstract (CPA)** approach and various mathematical tools including ICT tools

Apply concepts and skills learnt in **real-world context**

Communicate their reasoning and connections through various mathematical tasks and activities

Build confidence and foster interest in mathematics

Contents similarity



Polya's four steps problem solving (1957) ≒ Structured problem solving

1. **Understand the problem**
2. **Make a plan**
3. **Execute the plan**
4. **Look back and reflect**

- Pólya's 4 steps to problem solving and the **use of heuristics**, are important in helping one tackle **non-routine tasks** systematically and effectively (MoE, 2021).

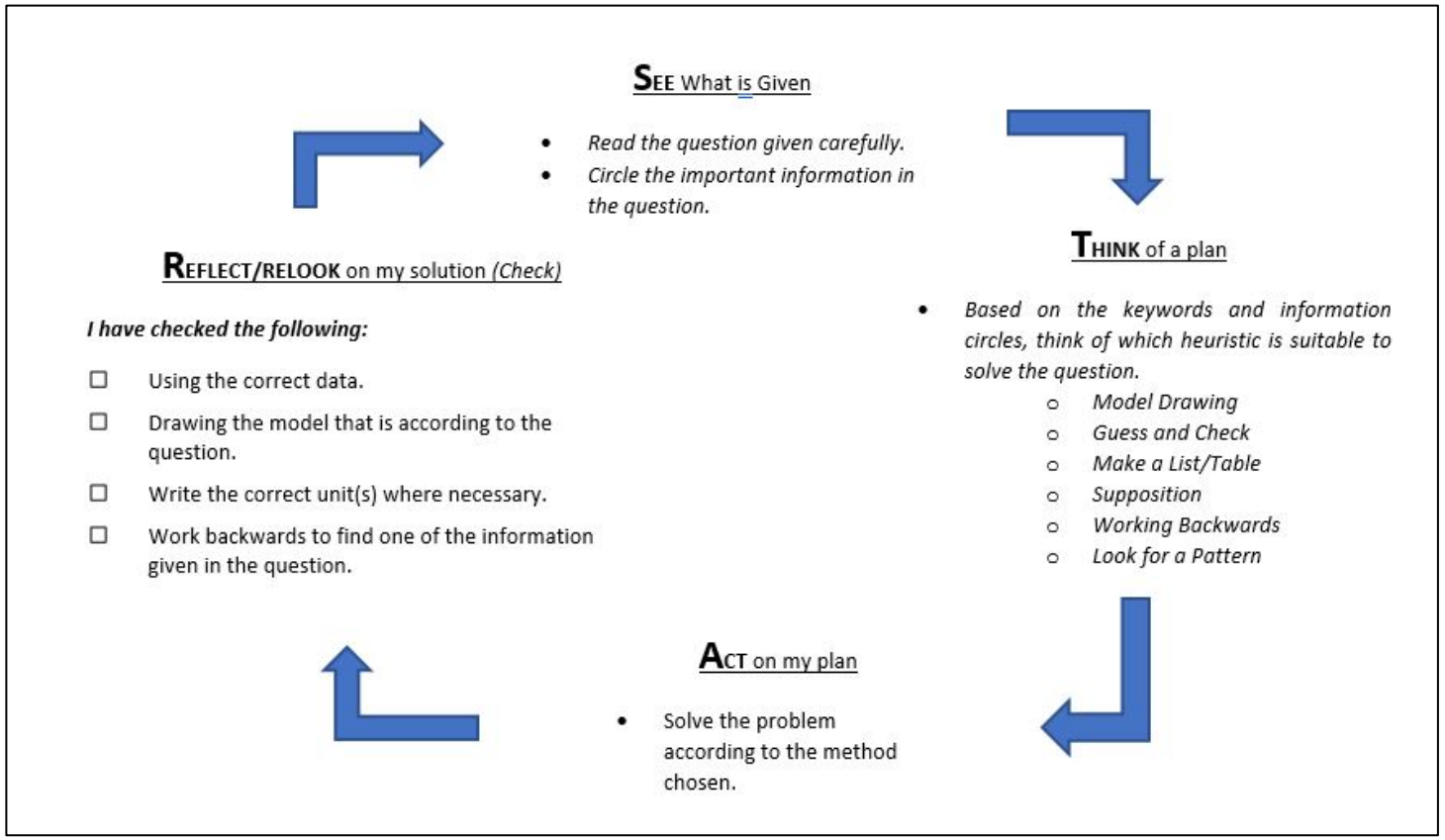
Structured Problem Solving (Stigler & Hielbert, 1999; Takahashi, 2006; Natan & Ishii, 2023) in Japan

1. **Understanding the problem (with diagram/table)**
2. **Individual work to have different solutions**
3. **(Pair work/group work)**
4. **Sharing ideas & whole class discussion (Neriage)**
5. **Conclusion & self-reflection (not only answer, but also the process/how to solve and reason)**

- **Carefully selected word problems and activities, and their cohesiveness**
- **Extensive discussion (Neriage)**
- **Emphasis on blackboard practice (Bansho)**

Example of Polya's PS in primary school textbook

Four-step PS & Structured PS



Polya' four steps in Singapore (Ngee Ann Primary School web site)

Structured problem-solving approaches in Japan (Natan & Ishii, 2023)

More example of Polya's four-step PS in primary school, Singapore

CPA (MoE, 2013; Leong, et al., 2015)

- The Concrete-Pictorial-Abstract (CPA) approach, based on **Bruner (1966)'s conception of the enactive, iconic and symbolic modes of representation**, is a well-known instructional heuristic advocated by the Singapore Ministry of Education since early 1980's.
- CRA (Concrete-Representations-Abstract)(Ketterlin-Geller et al., 2008)
- By CRA approach, Flores (2010): the low-achieving Grade 3 students show improvement in fluency and confidence in doing arithmetic computations involving subtractions.
- **Evidence of positive effect of using CRA on low achievers** in the area of **fractions** (Butler et al., 2003), **word problems** (Maccini & Hughes, 2000), simple **linear functions** (Witzel, 2003), and advanced linear functions (Witzel, Mercer, & Miller, 2003).
- CPA's uniqueness is in its **ubiquity** throughout the entire mathematics education community in Singapore. **CPA is a teaching strategy that is advocated by the Ministry of Education** (Ministry of Education, 2012), **embedded in textbooks used by schools** (Fan, 2012), and **taught in pre-service courses of mathematics teachers** (e.g., Chua, 2010; Edge, 2006).

Example of CPA in textbook of SG & JP

Example of CPA in textbook of SG & JP

Example of CPA in textbook of SG & JP

Metacognition (MoE, 2013; 2021)

(Definition)

- Refers to the **awareness of, and the ability to control one's processes**, in particular the selection and use of problem-solving strategies (**non-routine or open-ended problem**).
- Monitoring and **regulation of one's own thinking and learning**.
- Awareness of one's affective responses towards a problem
- Discuss their solutions, **reflect on what they are doing** and keep track of how things are going, and make changes when necessary.

(Reflection as conclusion)

- To conclude the lesson by using **Connect-Extend-Challenge**.
- How are the ideas and information presented, connected to what you already knew?
- What new ideas did you get that extend or pushed your thinking in new directions.
- What is still challenging or confusing? What questions or puzzles do you have now?

Activity based learning

- Learning by doing
- Using concrete manipulatives and experiences, students construct meanings and understandings

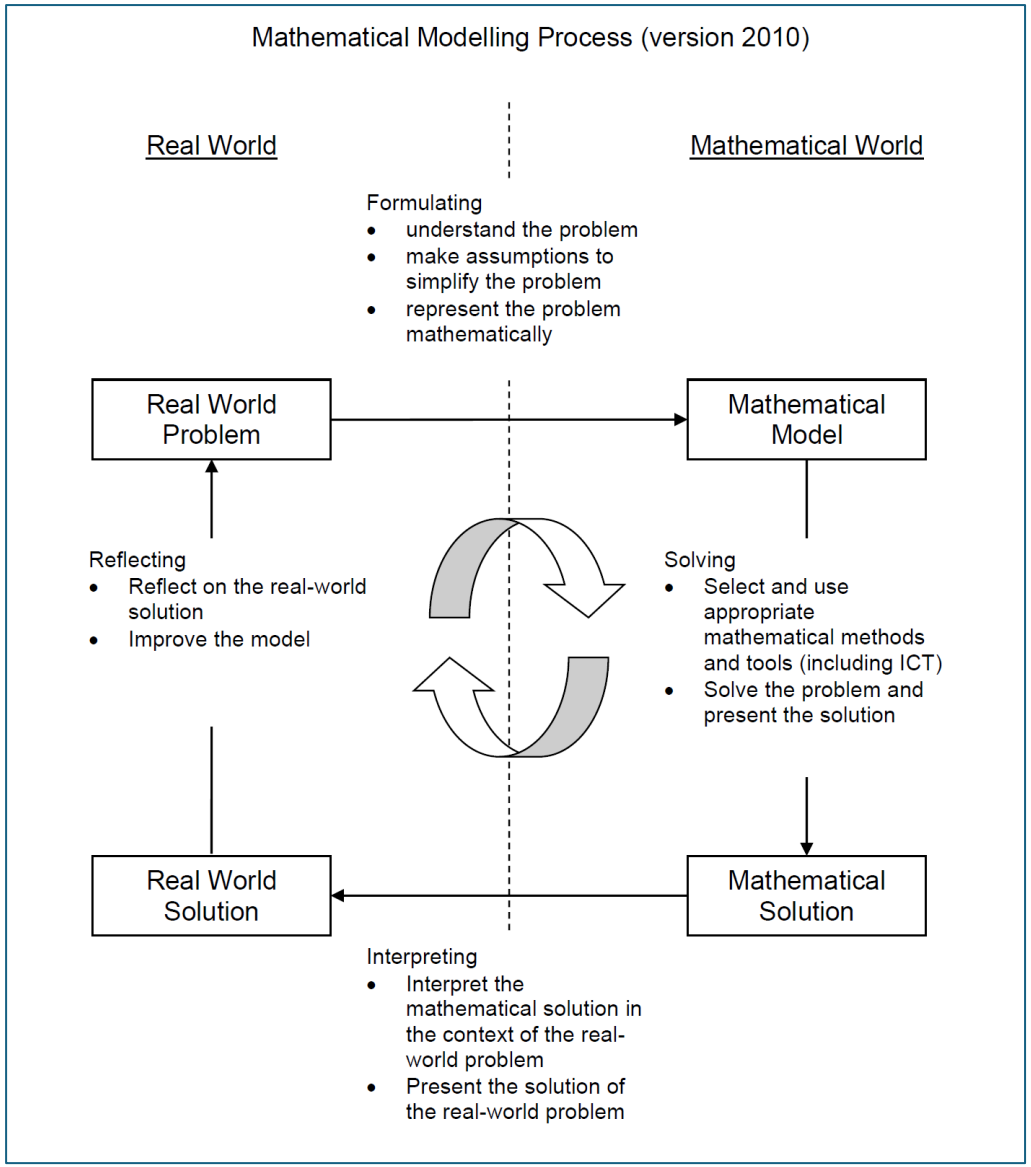
Activity environment

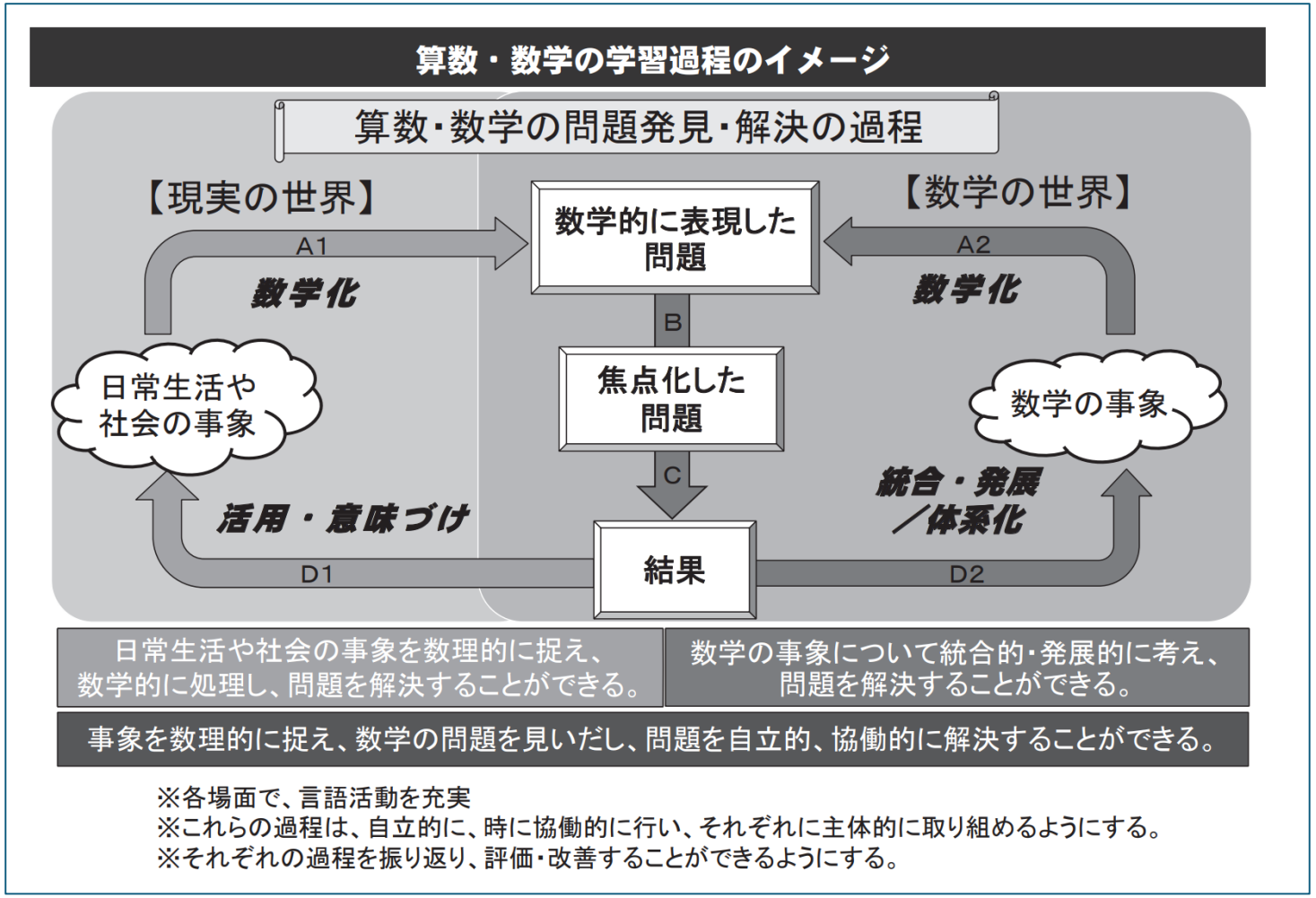
- Pair & group work are applied.
- Role in group work is instructed by teacher.
- Sometimes round table or round shaped desks are used to do group work.

Teacher-directed inquiry

- Instead of giving the answers, **teachers lead students to explore, investigate and find answers on their own**. Students learn to focus on specific questions and ideas and are **engaged in communicating, explaining and reflecting on their answers**. **They also learn to pose questions**, process information and data and seek appropriate methods and solutions. This enhances the development of mathematical processes and 21st century competencies (MoE, 2013).

Mathematical modeling in SG & JP





Help students to use Mathematical strategies (Thinking skills and Heuristics) (MoE, 2021; Akai et al., 2018)

- Thinking skill: classifying, comparing, sequencing, generalizing, induction, deduction, analyzing (from whole to parts), synthesizing (from parts to whole)
- Problem solving model such as **Polya's four-step strategy**
- **Heuristics**: **drawing a diagram (bar model, number bond, etc.)**, **tabulating**, guess and check, working backwards, simplifying a problem, considering special cases

Heuristics (as mathematical strategies) is one of the important target knowledge and skills for student to learn.

Drawing a diagram in textbooks

Number bond in SG (G1)

Only number block (G1)

Drawing a diagram in textbooks

Bar model in SG (introduced at G2)

Tape diagram in JP (introduced at G2)

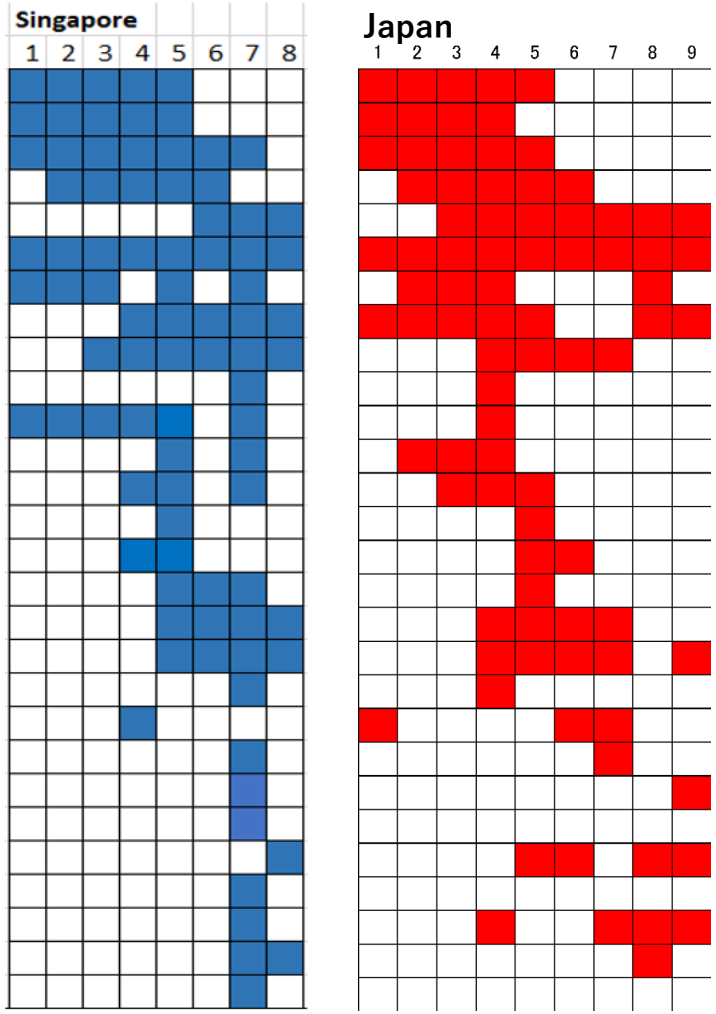
Structure of the bar model

Different characteristics of mathematics education between SG & JP

Different characteristics

- Small difference of contents
- Some difference in textbooks of both countries
- Direct Instruction (Singapore)
- ICT use for mathematics lesson & SLS (Singapore)

Small difference of contents



- Earlier learning of **multiplication & division concept (G1)**, **square & cube root (G6)**.
- Especially for **geometric constructions**, which are emphasized through primary education in Japan, Singapore does not do any compass constructions.
- In Japan, students start learning topics like equations and formulas very early in the Primary grades and continue through the different years, using **symbols such as '△' or '□'** instead of letters such as 'x' or 'y'.
- Singapore students do not study **inverse proportion** at the primary levels. Only direct proportion is introduced in terms of the idea of proportionality, but the word "proportion" is missing.

Structure of SG textbook

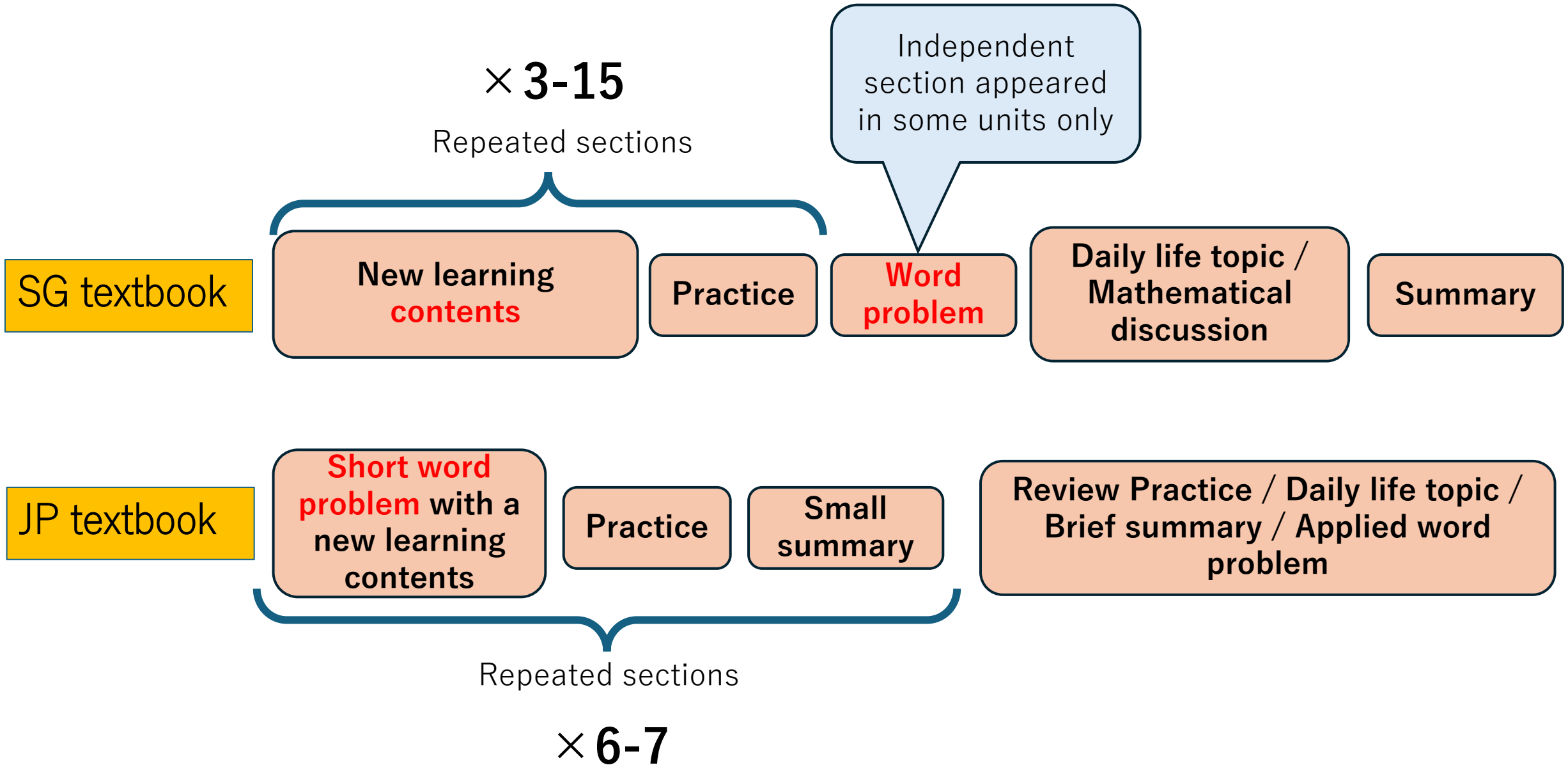
Structure of JP textbook

Difference of introducing new contents

Addition of Decimals in SG (G4)

Addition of Decimals in JP (G3)

Image of 1 unit in mathematics textbook



Direct instruction (MoE, 2013)

- This approach is about explicit teaching. **Teachers introduce, explain and demonstrate new concepts and skills**. Direct instruction is most effective when students are told what they will be learning and what they are expected to be able to do.
- Recommended teacher to demonstrate how to use **e.g.**, **Polya's four-step problem-solving strategy** and **make visible the thinking processes**.
- Of course, teachers should use students' response to modify his/her explanation and demonstration, picking up some of them for further discussion (the same as Japan)

Direct instruction

Effectiveness of Singaporean Mathematics Strategy (Sakai et al., 2018; Akai et al., 2020):

- Mathematical strategies in Singapore is almost the same as the mathematical viewpoints and thinking (数学的な見方・考え方) in Japanese curriculum.
- In Singapore, many schools not only use the mathematical strategies for individual non-routine problem-solving activities, but **also provide time and drill materials for learning the strategies themselves**. This allows students to use the strategies as part of their previous knowledge without having to wait for new content of the individual units.
- In Japan, it would be a good idea to implement strategies learning activities (including **learning the names of the strategies**, e.g., Polya's four-step problem solving, drawing a figure, table, etc. →Akai et al. (2020) **Clarifying and learning strategies was confirmed to give good impact on slower learners' involvement in problem solving process in Japan**.

My (Ishizaka) concerns are:

- **Neriage** among different solutions is still good in Japan. But, **always cost-benefit? Always efficient? It's good for slow learners? It's good to expect teachers to apply it in other countries?**

ICT use & SLS in Singapore

- Not completely distributed 1 device to 1 child. But, the devices are frequently used.
- History to apply ICT in classroom is much longer than Japan. iPad, PC, Projector (or touch panel TV), (Overhead Camera (OHC)) are basic device set for teacher.
- In addition, teacher frequently use potable micro phone with speaker.

ICT use & SLS in Singapore

- The Singapore **Student Learning Space (SLS)** is the Ministry of Education's **core platform for teaching and learning** and one of its key initiatives to transform the learning experiences of Singaporean students through the purposeful use of technology.
- The SLS is continually being developed in response to the needs of students and teachers. **Curriculum-aligned resources and system tools are continually being improved and developed in line with suggestions and feedback from teachers and students** to cater to students' diverse and evolving learning needs.
- The SLS's agile development allows it to quickly adapt to new demands from users or policy changes. It is also built as an open system that can supplement its core resources and features with external content and tools. The SLS has already whitelisted and integrated more than 250 sites / tools.
- Sharing students' answers/ideas during lessons is done through SLS or Padlet, etc. SLS can be used before-after-lesson learning platform, too.

SLS website (https://www.learning.moe.edu.sg/)

SLS role

- Connect between teacher and students and among students, and let them interact among them, too.
- Teacher set up all the materials used for lessons based on the structure of unit contents.
- Record what they think to solve and answer, reflect how they solve (meta-cognition, too)

Advantage & challenges of platform (like SLS) use

(Advantage)

- **Easy for students to follow the lesson**
- **Easy to share students' ideas**
- **Easy to discuss based on them**

(Challenges)

- **Harmonization between writing on the platform (SLS) and note/worksheet writing (as lesson design and portfolio)**
- **Oral discussion is enriched by the platform???**
- **Distraction by using ICT tools**

ICT use in Japan

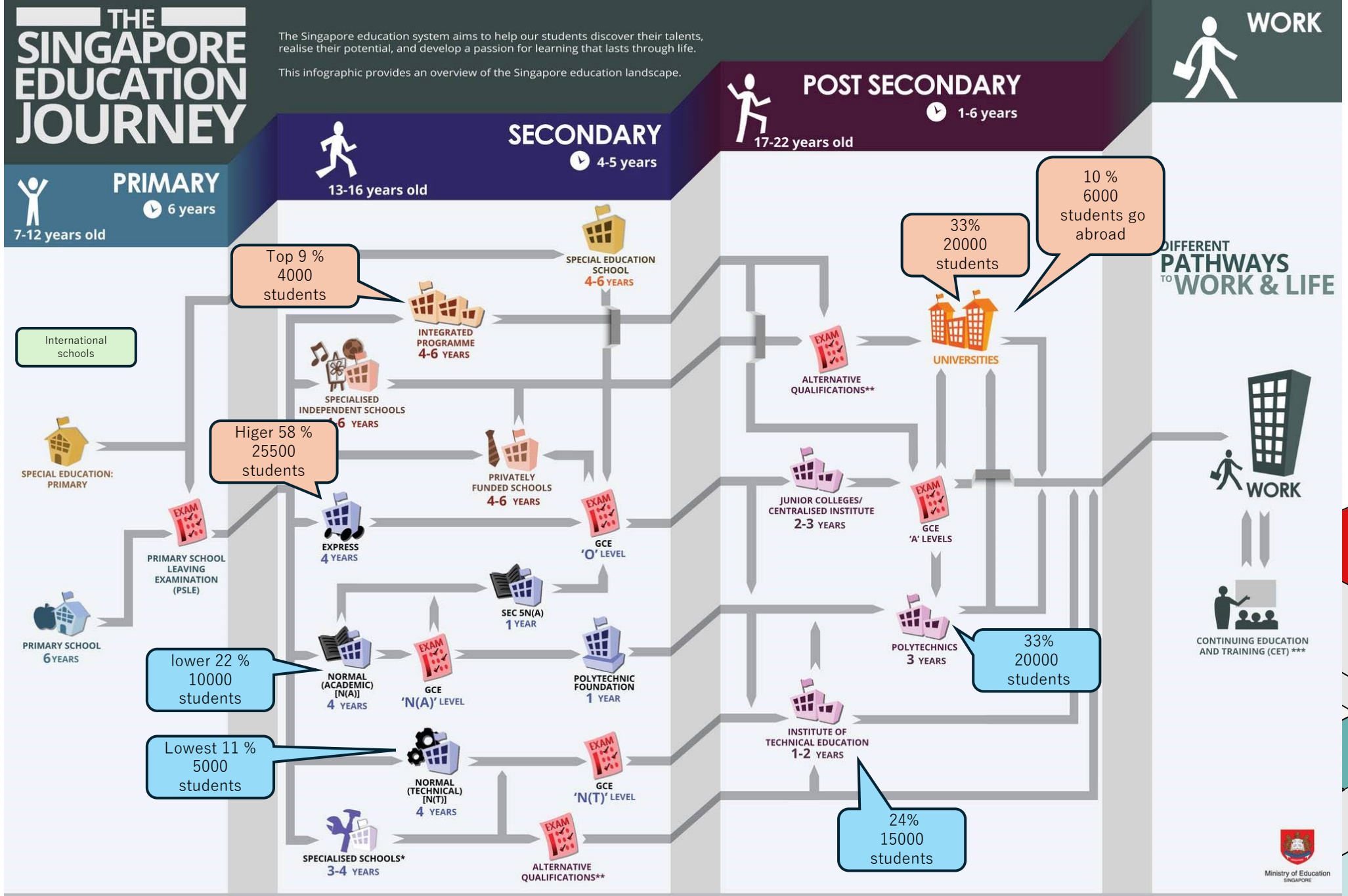
- Thanks to GIGA School Initiative, all schools and students benefit the use of tablet/PC.
- Multiple platform and application are used, but **inconsistently**. Hardware, too.
- There are some good platform and application (LoiLo Note, MetaMoji, Google Classroom, etc.)
- GIGA school initiative will succeed if MEXT shares good practices efficient and effectively. SLS would be necessary…

Other difference in education between SG & JP

THE SINGAPORE EDUCATION JOURNEY

The Singapore education system aims to help our students discover their talents, realise their potential, and develop a passion for learning that lasts through life.

This infographic provides an overview of the Singapore education landscape.



*** Specialised schools** offer customised programmes for students who are inclined towards hands-on and practical learning. These schools include Northlight School, Assumption Pathway School, Crest Secondary School and Spectra Secondary School, which is due to open in 2014.

** **Alternative Qualifications** refer to qualifications not offered by the majority of mainstream schools in Singapore.

*** **Continuing Education and Training (CET)** is designed for adult learners or companies looking to upgrade the skills and knowledge of their employees.

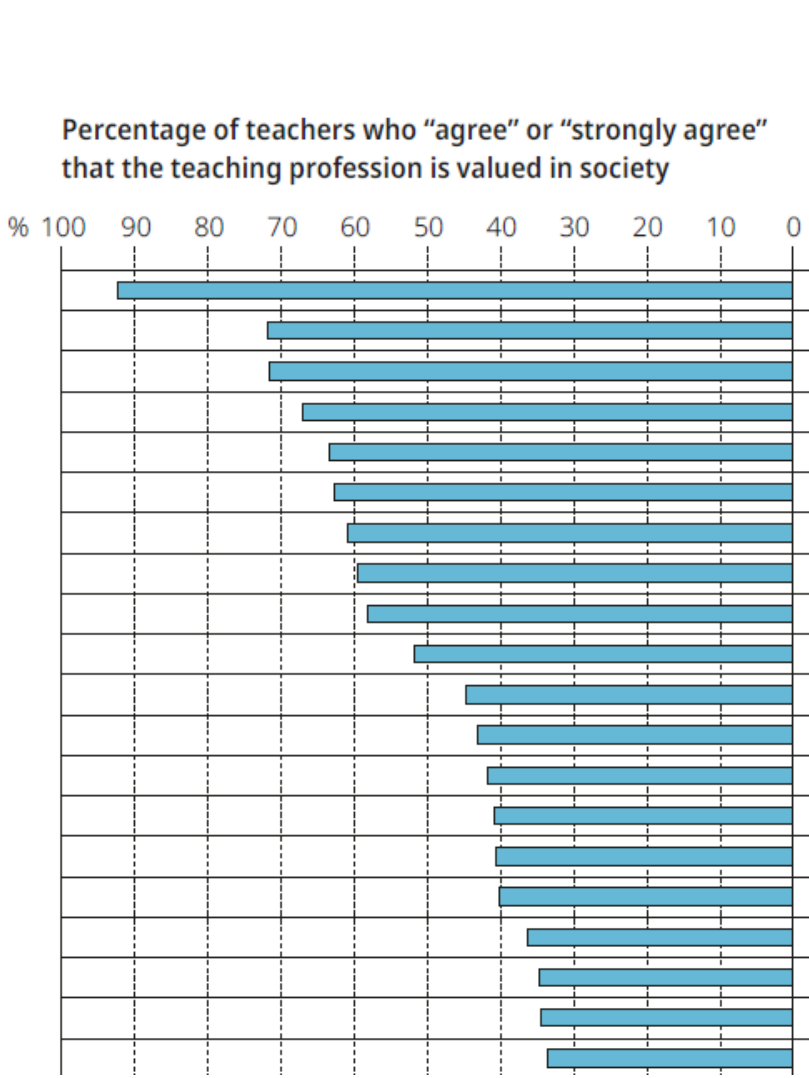
Comparison between SG & JP (https://www.theglobaleconomy.com/)

Items	Singapore	Japan
GDP per capita	5th ($82,807)	34th ($34,017)
GDP growth rate	3.65%	0.95%
Unemployment	3.59%	2.6%
Youth unemployment	7.57%	4.2%
Life expectancy	83.44	84.45
Fertility rate	1.12	1.3
Political corruption	0.007	0.059
Economic freedom Index (out of 100)	84	68
Cost of living index (100 as NY)	104 (1st)	69 (60th)
Percent of Public spending on education to GDP	2.39%	3.32%
Percent of public spending on education to total	13.28%	7.43%
Teachers' salary average (OECD, 2023 and others)	$5000-6000 (tax 2-24%)	$4000 (tax15-55%)
PISA ranking 2022 (reading, math, science)	1st, 1st, 1st	3rd, 5th, 2nd

Comparison between SG & JP (OECD, 2018)

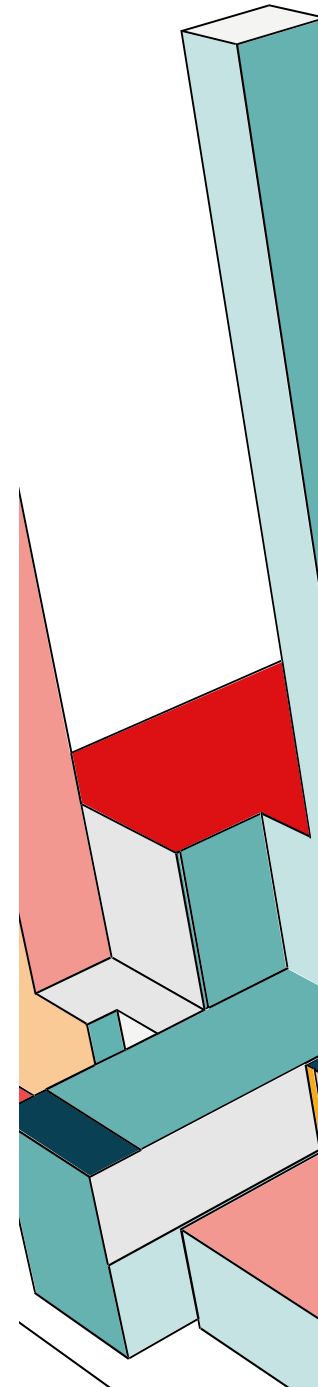
Figure II.2.1 **Teachers' views of how society values their profession, by teacher characteristics**

Results based on responses of lower secondary teachers



	Difference by teacher characteristics		
	Male – Female	Age 50 and above – under age 30	Experienced – novice teacher[1]
Viet Nam	–		
Singapore		+	
United Arab Emirates	–		–
Korea	+		–
Kazakhstan	+	–	
Alberta (Canada)			
South Africa			
Shanghai (China)			–
Finland		–	–
Saudi Arabia	–	+	
Australia	+	–	
Russian Federation	+	–	–
Mexico	+	+	
Romania	+	–	–
Georgia	+	–	–
Colombia	+		
United States	+		
Norway		–	–
Japan		+	
New Zealand	+		

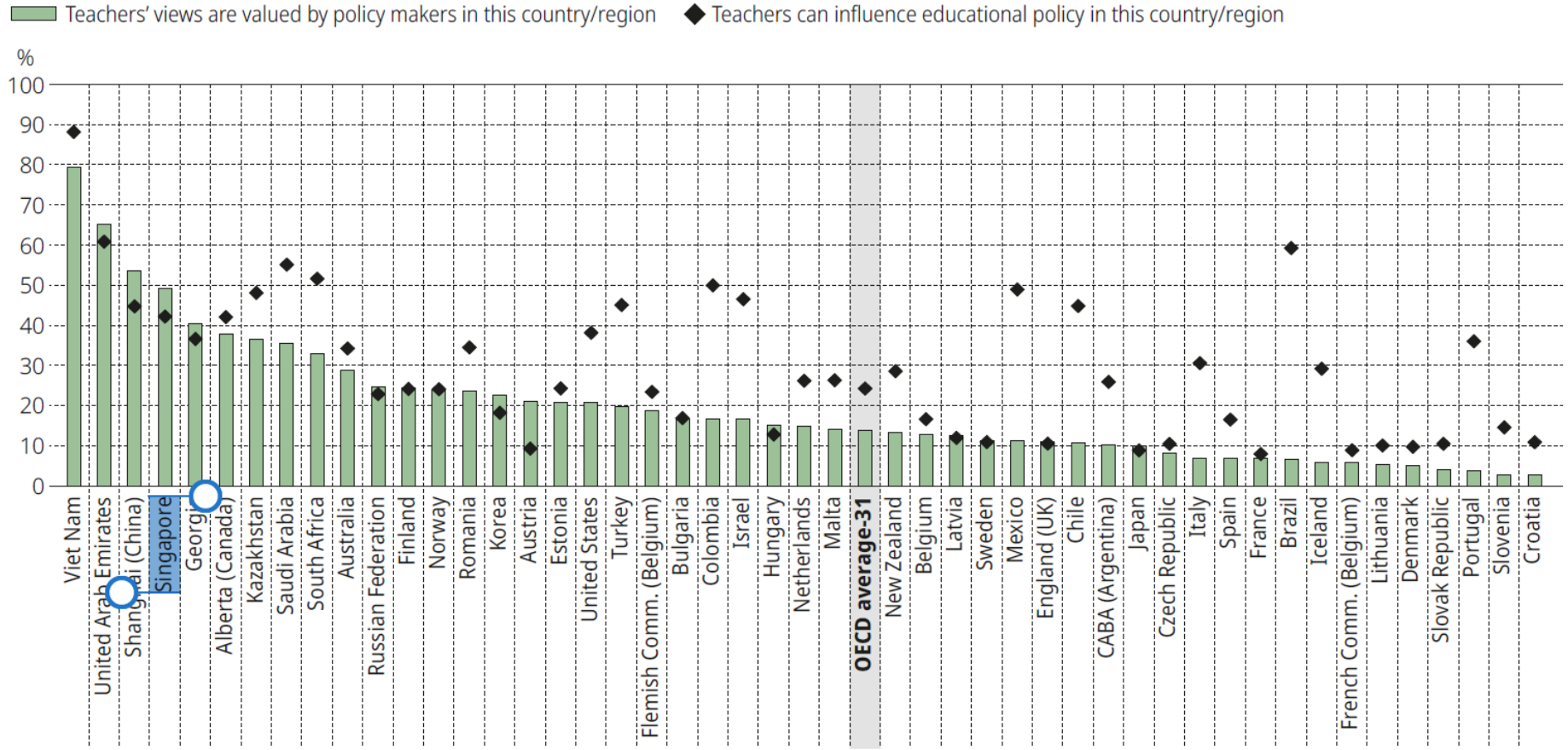
\+ Positive difference
– Negative difference
Difference is not significant
Missing values



Comparison between SG & JP (OECD, 2018)

Figure II.5.16 **Teacher's views on their relation with policy making**

Percentage of lower secondary teachers who "agree" or "strongly agree" with the following statements



Countries and economies are ranked in descending order of the percentage of lower secondary teachers who "agree" or "strongly agree" that teachers' views are valued by policy makers in this country/region.

Source: OECD, TALIS 2018 Database, Table II.5.47.

StatLink http://dx.doi.org/10.1787/888934084266

International Educational Cooperation of Singapore

Who is in charge of international cooperaion for education ?

- **Singapore Cooperation Programme (SCP):** Managed by the Ministry of Foreign Affairs
- **National Institute of Education (NIE) International Pte Ltd.:** Singapore's main teacher education institution and is involved in international teacher training and development programs. It collaborates with overseas educational institutions to conduct research and develop educational initiatives.
- The **Economic Development Board (EDB)** promotes Singapore as a global schoolhouse, attracting international students and educational institutions to set up campuses in Singapore. The EDB works closely with the MOE and other stakeholders to enhance Singapore's position as an education hub.
- **ASEAN University Network (AUN)**: Singapore participates in the AUN, which facilitates collaboration and exchanges among universities in ASEAN countries. This network promotes regional educational cooperation and integration.
- **Council for Private Education (CPE)**:The CPE regulates private education institutions in Singapore, ensuring they meet quality standards and promoting Singapore as a destination for international students.

Singapore Cooperation Programme (SCP)

- Singapore has provided **technical assistance** to other developing countries since the 1960s. As a country whose **only resource is its people**, Singapore believes that human resource development is vital for economic and social progress. Singapore itself has benefited from training provided by other countries and international organisations.
- In 1992, the **Singapore Cooperation Programme (SCP)** was established to bring together under one framework the various technical assistance programmes offered by Singapore. Through the SCP, the range and number of training programmes were increased to share
- Singapore's development experience with other developing countries. Working with more than 50 local and international partners, SCP have shared development experiences with close to 150,000 government officials from 180 countries, territories and intergovernmental organisations. The SCP is managed by the **Technical Cooperation Directorate of the Ministry of Foreign Affairs**.
- Annual budget is approx. SGD 10 million.

NIE international Pte Ltd

- NIE International Pte Ltd (NIEI) was incorporated on 1 Apr 2009. As the business consultancy arm of the National Institute of Education, teacher education and leadership training is shared with the rest of the world.
- NIEI was established in April 2009 and it is the consultancy and training **private arm** of the National Institute of Education (NIE) Singapore.
- NIEI provides **training courses** and **consultancy services**, tapping on NIE's expertise and knowledge, accrued over NIE's 50 years of pedagogical practice, knowledge and research.
- NIEI focuses on niche areas in teacher education, **school management** and educational **leadership** programmes.
- E.g., "Leaders in Education Programme International (LEPI) (1 week)", "Master in Educational Administration (1 year in Chinese)", "Postgraduate Diploma in Higher Education (1 year)"

Importation of Singaporean mathematics

Introduction of Singapore Math

- Singapore Math is the name given to Singapore's mathematics teaching methodology and materials, which also means the materials provided by Marshall Cavendish Education (MCE).
- These materials include textbooks and manipulative.
- MCE is a Singapore-based educational publisher and provider of educational materials and textbooks, even workshops/training
- Singapore Math has been used in many countries since 2000, including the United States and the United Kingdom.

https://www.singaporemath.com/pages/what-is-singapore-math

Characteristics of Singapore Math

CPA (Concrete Pictorial Abstract) Approach: Introduces concepts in a tangible way and progresses to increasing levels of abstraction.

Number Bonds: Shows the part-whole relationship between numbers.

Bar Modeling: Helps students visualize a range of math concepts, such as fractions, ratios, and percentages. Allows students to determine the knowns and unknowns in a given situation.

Mental Math: Helps students develop number sense and flexibility in thinking about numbers.

Impact of Singapore Math

Textbook | Use of manipulatives | Mixed-ability groups Emphasis on mastery | Teacher training about Singapore Math

- Lindorff et al. (2019): In UK, **time-lagged positive impact** of mathematics textbook and teaching approach on G1 students' academic performance. Quality of teaching improved in short-run.

Mixed-ability groups Emphasis on mastery | Developed materials | No extensive homework | Bar-modeling | Use of manipulatives | Teacher training

- Jerrim & Vignoles (2015): In UK, impact of intervention on primary (G1) & secondary students (G7) (**only high quality schools**)' performance is confirmed.

- In both articles, teachers' fidelity of intervention is discussed, but no solution

Impact of Singapore Math

CPA based Textbook | Use of manipulatives | Instructional Pathway (direct instruction) | Flexible & interactive teaching and learning

- Jaciw et al.(2015): in Nevada, US, “Math in Focus: Singapore Math (MIF)” (1 year program) had **impact on students (G3-5) problem-solving and procedural skill**. No different impact based on ethnic, economic groups.

- Fidelity of intervention was:
  A) 38% teacher use 80% teaching time for MIF
  B) 82% teacher applied the Instructional Pathway
  C) 65% teachers applied CPA approach

Impact of Singapore Math

Lesson Study

CPA based Textbook | Bar-modeling | Use of manipulatives | Problem solving approach

- Kakoma(2015): In South Africa, Singapore Mathematics Curriculum (SMC) was applied (GR to G3). Teacher answered that SMC is effective to teach and learn because of **user-friendly teacher guide and manipulatives**.
- Challenge: develop problem-solving lessons, bar-model **drawing**, difficulty of **simultaneous SMC implementation**.

- No quantitative evidence were confirmed among third world countries (I just quickly searched, though).

Any lessons for Japanese International Cooperation

Mental calculation

Direct instruction

Indication of pair work/group work in textbook/teacher guide, clearly

Visible and understandable introduction of strategies: CPA, Heuristics (diagram/table), Polya's four-step problem-solving strategy, etc.

Experience of harmonization between analogic and digital pedagogy (e.g., Bansho, formative/summative assessment)

Experience of Applied Learning Programme in Singapore (integrated studies in Japan)≒STEM/STEAM education

Any lessons for Japanese International Cooperation

- **Importance of common characteristics (CPA, Heuristics (drawing diagrams))**
- **Direct instruction (teaching contents→practice→word problem)**
- **Short-run and middle & long-run survey is important.**
- **Visible and understandable introduction of strategies: CPA, Heuristics (diagram/table), Polya's four-step problem-solving strategy, etc.**
- **Indication of pair work/group work in textbook/teacher guide, clearly**
- **Experience of harmonization between analogic and digital pedagogy (e.g., Bansho, formative/summative assessment)**
- **Experience of Applied Learning Programme in Singapore (integrated studies in Japan)≒STEM/STEAM education**