

Book Review

Effective Mathematics Lessons through an Eclectic Singapore Approach

(Yearbook 2015 - Association of Mathematics Educators)

Wong Khoon Yoong (2015)

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This paper reviews the book *Effective Mathematics Lessons through an Eclectic Singapore Approach* authored by Wong Khoon Yoong. The book is the seventh in the series of Yearbooks produced by the Association of Mathematics Educators in Singapore. The book is unique in the sense that unlike other yearbooks of the Association, this one was not a compilation of papers presented at an annual conference of the Association. Wong, an eminent mathematics educator in Singapore was invited by the Association to write the 2015 yearbook and share his wisdom of teaching and learning of mathematics in Singapore schools. Wong's acceptance of the invitation has resulted in a valuable resource for mathematics teachers in Singapore and elsewhere.

The book provides a range of learning experiences and teaching strategies that mathematics teachers can judiciously select and adapt in order to deliver effective lessons to their students at the primary to secondary level. The ultimate goal is to develop successful problem solvers who are able to understand concepts, master fundamental skills, reason logically, apply mathematics, enjoy learning, and strategize their thinking. These qualities will prepare students for life-long learning and careers in the 21st century. The materials covered are derived from psychological theories, education praxis, research findings, and mathematics discourse, mediated by the author's professional experiences in mathematics education in four countries over the past four decades. They are organized into ten chapters aligned with the Singapore mathematics curriculum framework to help teachers and educators from Singapore and other countries deepen their understanding about the so-called "Singapore Maths".

Brief synopsis of the ten chapters are as follows.

1. *Curriculum: Map the Intended, Implemented, and Attained Landscape*

This chapter explores the three types of curriculum, namely the intended, the implemented, and the attained linking them to the nature of mathematics as a discipline. It explains the framework of the intended school mathematics curriculum in Singapore, providing readers with the rationale of what underlines it. Wong was a member of the review committee in the late 1980s that designed the framework, known as the "Pentagon framework" amongst educators in Singapore schools. This framework has been steadfast for the last three decades and continues to frame the intended

school mathematics curricula for Singapore schools. The “how” of the implementation of the curricula is also examined highlighting the various strategies alongside their respective rationale. Lastly the attained curriculum, addressing the “how well” is explored. The three goals of assessment, namely Assessment of Learning, Assessment for Learning and Assessment as learning guide the explorations.

2. Concepts: Build Meanings and Connections

This chapter deals with the essential features of concept formation, which is the first component of the pentagon framework and the base of the pentagon. It explores concepts from the perspectives of meanings, examples, non-examples that can be summarized using the Frayer’s Model. It also reviews modes of representations, and distinguishes modes of representations from modes of processing. Lastly conceptual connections, a much neglected aspect of concept development in many classrooms, is illuminated through simple strategies such as Carroll diagram, Venn diagram, Tree diagram, concept maps and concept questions.

3. Skills: Use Rules Efficiently

This chapter explores the nature of mathematics skills and how direct instruction can be better implemented by including alternative explanations, addressing student mistakes, covering a variety of worked examples and paying attention to the cognitive load of problems. It distinguishes telling and explaining, which is key to effective mathematics lessons. It also illuminates deliberate practice, a characteristic of Asian mathematics classrooms, through a variety of approaches.

4. Processes: Sharpen Mathematical Reasoning and Heuristic Use

This chapter notes that mathematical processes are competencies higher than standard skills and these are necessary if students wish to solve non-routine, unfamiliar, extended, or contextualized problems. Wong proposes teaching inductive-experimental justification through a combination of direct instruction and guided discovery approaches. Several examples of mathematics instruction are used to illustrate teaching in this way. The chapter also shows how deductive proofs and heuristics can help teachers facilitate the development of mathematical knowledge amongst their students. A key Singapore-centric heuristic for problem solving is also discussed in the chapter.

5. Applications: View the World Through Mathematical Lenses

This chapter explicates two models related to the ability to use mathematics in daily life. The first adds context knowledge to the Singapore mathematics curriculum framework and the other embeds National Education into the mathematics curriculum. Mathematical modelling is discussed as an extension of real-life applications. The examples in the chapter shows how the two models can be used to achieve the application goal of the mathematics curriculum in mathematics lessons.

6. ICT: Be Its Prudent Master

The premise of the chapter is that technology is just a tool and the teacher is the most important in facilitating the learning of mathematics. It also acknowledges that Information and Communications Technology (ICT) is an umbrella term that covers a vast range of tools. The chapter examines four major modes of ICT use; Tutor mode – learn from the computer, Tutee mode – learn through programming the computer, Tool mode – Learn with the computer, and Co-Learner Mode. It also examines a computer-based assessment system.

7. Attitudes: Energise Learning with Emotional Power

This chapter examines the meaning, measurement, research, and interpretations of affective constructs, especially attitudes and motivation. It details the **M_Crest** Framework that teachers may draw on to frame their lessons for effective instruction. The framework centres on six aspects that follow. **M** = Meaningfulness – students have a strong need to make sense of the mathematics they learn. **C** = Confidence – students need to gain confidence in their abilities to learn complex mathematics and to solve mathematics problems. **R** = Relevance – both cognitive relevance and emotional relevance must be present. Students must see the value in learning the mathematics (cognitive relevance) and the learning experiences must satisfy their emotional needs (emotional relevance). **E** = Enjoyment – enjoyment in doing a learning task is a powerful factor in getting students to complete the task. **S** = Social Relationships – Teaching is a social activity and relationships amongst teacher – students and student – student must be cordial and supportive. Some may refer to this as a safe environment. **T** = Targets – clear and achievable targets are necessary to motivate and engage students in mathematics instruction.

8. Metacognition: Strategic Use of Cognitive Resources

The chapter notes that the Singapore school mathematics curriculum refers to two aspects of metacognition: self-regulation of learning and monitoring of one's own thinking. It proposes two frameworks for metacognition, one for each of these two aspects and elaborates on several strategies which can facilitate the development of the two metacognitive processes to improve the mathematics learning and problem solving. The framework about self-regulation of learning imbues three learning strategies, namely monitor learning objectives, deliberate practice and overcome mistakes. The framework guiding one's own thinking applies to problem solving and is linked to Polya's problem solving model. Teacher and student prompts for each of the four problem solving stages are provided to guide students monitor their own thinking during problem solving.

9. School Curriculum: Prepare Thoughtful Plans

This chapter provides guidance on how to consciously design effective mathematics lesson plans and practical worksheets to engage students with rich learning experiences. Strategies discussed in chapters 2 to 8 are drawn on to illustrate the elements of thoughtful lesson plans for enactment. The chapter also acknowledges that penning down details for every lesson may not be feasible for practicing teachers, but nevertheless teachers must prepare essential examples and questions for all lessons. In addition, periodically they should write detailed plans and reflect on the effectiveness of their lessons.

10. Professional Development: Become Metacognitive Teachers

The last chapter in the book address the need for professional development of teachers, particularly for them to become metacognitive teachers. In this chapter Wong proposes a framework for Metacognitive Mathematics Teacher Standards. The framework comprises six aspects: mathematical knowledge, knowledge of Maths curriculum, knowledge of students, Maths-based pedagogy, knowledge of assessment and life-long learning and values. The framework is supported by an extensive review of literature that Wong has undertaken and merits consideration for adoption by teachers when considering their professional development needs and learning trajectories.

The book strikes a balance between mathematical rigour and pedagogical diversity, without rigid adherence to either. This is relevant to the current discussion about the relative roles of mathematics content knowledge and pedagogical content knowledge in effective teaching. It also encourages teachers to develop their own philosophy and teaching styles so that their lessons are effective, efficient, and enjoyable to teach. The book is a good read for graduate students researching on mathematics classroom practice in Singapore schools and teachers of mathematics as it helps them appreciate the theory-practice nexus in mathematics pedagogy.

Reviewer

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