



Design Principles for Raising Students' Awareness of Implicit Features of Ratio: Creating Opportunities to Make and Catch Mistakes

Sze Looi Chin

National Institute of Education,
Nanyang Technological University
nie19.csl@e.ntu.edu.sg

Seeing a problem and immediately knowing how to solve it is typically desired in students. However, it can also lead to impulsive thinking, where students are unconscious of critical features of concepts and consequently make negligent mistakes (Lim & Wagler, 2012). To address this issue, the teacher in this study, Tanya (pseudonym), designed *instructional materials* (IMs) in the form of worksheets, that contained her intended curriculum (Remillard & Heck, 2014) and were used to manage her students' impulsive behaviour. This study aimed to answer the research question: "What design principles does a secondary mathematics teacher use to design instructional materials to manage students' impulse thinking and raise their awareness of important features of concepts?"

To address this question, the study adopted a qualitative case study approach. The data presented here is part of a larger study on secondary mathematics teachers design IMs. The data collection spanned Tanya's IM design and implementation phases, with a focus on identifying the key mathematical ideas featured in her IMs, her anticipations of student responses, and the learning opportunities facilitated by her design decisions.

Two key design principles emerged from the analysis and are explained using four sets of tasks from Tanya's IMs. Throughout her IMs, specific tasks played a pivotal role in achieving Tanya's goal of managing the pace of students' thinking. These tasks were selected, modified, and created to raise students' awareness of implicit features of ratio through her first design principle (DP1): *creating opportunities for making mistakes*. These tasks were also situated within sets to "change the momentum" of her students' thinking through her second design principle (DP2): *sequencing tasks to lead students to make and recognize mistakes*.

Tanya's use of DP1 and DP2 introduced the concept of *catch tasks*, tasks intentionally designed to elicit incorrect solutions, helping students identify errors and grasp implicit concepts they might otherwise overlook. This study highlights that effective teaching doesn't require overly complex, intricate, or collaborative tasks, challenging conventional beliefs (Swan & Burkhardt, 2014). It also emphasizes the value of allowing students to engage in both *thinking fast* and *slow* (Kahneman, 2012) to address crucial learning issues.

References

- Kahneman, D. (2012). *Thinking, fast and slow*. Farrar, Straus and Giroux.
- Lim, K. H., & Wagler, A. (2012). Impulsive-analytic disposition in mathematical problem solving: A survey and a mathematics test. In J. Dindyal, L. P. Cheng, & S. F. Ng (Eds.), *35th Annual Conference of the Mathematics Education Research Group of Australasia*. MERGA.
- Remillard, J. T., & Heck, D. J. (2014). Conceptualizing the curriculum enactment process in mathematics education. *ZDM - Mathematics Education*, 46(5), 705-718. <https://doi.org/10.1007/s11858-014-0600-4>
- Swan, M., & Burkhardt, H. (2014). Lesson design for formative assessment. *Educational Designer*, 2(7), 1-41.