Developing Critical, Adaptive, and Inventive Thinking through Mathematics: A Game-Based Approach

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Mathematically rich games can be effective in engaging students (Yeo, 2007), in exploring and applying key mathematical ideas, and in increasing motivation to learn mathematics (Heshmati et al., 2018). Existing literature has largely focused on identifying the key characteristics of such games and providing detailed illustrations of specific examples. However, there is comparatively limited literature detailing general guidelines for creating or modifying mathematically rich games, for implementing mathematical games in the classroom, as well as for teachers' facilitation of students' mathematical work during games (Heshmati et al., 2018) to support the development of students' critical, adaptive, and inventive thinking, a key component of the emerging 21st Century Competencies (Ministry of Education Singapore, n.d.). This study addresses this gap by reviewing current game-based approaches to distil a framework consisting of design principles for selecting, developing, and implementing mathematically rich games in classrooms. The key principles include the centrality of mathematics in gameplay, student engagement, a balance of skill and luck (Russo et al., 2018), and other factors such as accessibility and feasibility. Based on these design principles, I developed a rubric to assess the design and use of games for mathematics instruction and outlined key strategies for their effective implementation in the classroom (Klooger et al. 2025). In addition, the same framework can be used to evaluate the game's affordances after implementation.

In this presentation, I will illustrate the use of the framework with two specific examples of mathematically rich games–Battleship and Tower of Hanoi–and suggest how these games can be implemented in mathematics classrooms. Lastly, implications for practice and directions for future research will be discussed.

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