Informal Knowledge and Informal Strategies for Whole Number Multiplication and Division

Eunmi Joung
https://orcid.org/0000-0003-4028-3861
Utah Valley University, USA

EXECUTIVE SUMMARY

It is widely recommended to use both formal and informal strategies in mathematics teaching and learning. This study first identified the percentages of students' use of formal and informal strategies, then described the specific strategies applied by students. Furthermore, the study categorized the themes of real-life word problems created by students using informal strategies, providing insight into commonly understood concepts. Using a qualitative quasi-experimental design, thematic analysis was conducted to categorize similar themes in students' word problems. The results showed a general increase in the percentage of students using both formal and informal strategies from pre-test to post-test, across both multiplication and division operations. The themes of word problems were also categorized. Moreover, the study identified the most frequently used themes in the real-life word problems created by students. This insight can assist mathematics educators in tailoring their teaching methods to enhance students' understanding of these concepts.

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CASE DESCRIPTION

Introduction

During the last three decades, the importance of different approaches to teaching mathematics has been emphasized in students' mathematics learning including formal and informal approaches (Große, 2014; Ma, 1999; Rittle-Johnson & Star, 2009). Also, the *Principles and Standards for School Mathematics* (NCTM, 2000) points out that teachers need to adapt their instruction (e.g., formal strategies) to students' existing knowledge (e.g., informal strategies). To build on their procedural fluency and conceptual understanding instructors can start by having students talk about the informal strategies they naturally developed before entering school. Likewise, the *Realistic Mathematics Education* (RME) movement in the Netherlands has found that a fundamental aspect of learning written calculations evolves gradually from various levels of the ability to invent informal strategies to the higher-level formal strategies that involve whole class discussion regarding the strategy choice (Van den Heuvel, 2001). This means that both students' procedural skills and conceptual understanding could be enhanced by using informal strategies in mathematics education. Examining both formal and informal strategies provides a comprehensive view of students' mathematical understanding. This approach allows educators to build on students' intuitive understanding while introducing more advanced formal methods, potentially enhancing procedural fluency, conceptual understanding, and problem-solving abilities (Verschaffel et al., 2009; Große, 2014). By considering both types of strategies, instructors can better adapt their teaching to students' existing knowledge (NCTM,2000).

While much research has focused on K-12 students, less is known about how undergraduate students, particularly those in STEM fields, utilize formal and informal strategies in fundamental mathematical operations (Maciejewski & Star, 2016). This study focuses on undergraduate STEM students, as their mastery of fundamental mathematical concepts is crucial for their academic success and future careers. Many college students demonstrate gaps in mathematical understanding that hinder their academic progress (Ngu et al., 2018), with a significant number requiring remedial math courses before advancing to higher-level STEM coursework (Chen & Simone, 2016). Understanding the formal and informal strategies employed by college students in fundamental mathematics can inform the development of more effective instructional methods and interventions (Hodara, 2013), potentially improving STEM retention rates (Seymour & Hunter, 2019) and better preparing students for success in calculus and other advanced mathematics courses crucial for STEM disciplines (Bressoud et al., 2015). Furthermore, analyzing students' created

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