

Chapter 16

Constructing Written Arguments for Developing Mathematical Reasoning for Students With Learning Difficulties in the Elementary Grades

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ABSTRACT

Using argument writing to enhance students' mathematics learning has been shown to increase students' content knowledge. Investigating argument writing has also been found to increase the content knowledge and quality of mathematical reasoning of students with learning challenges. This chapter examines the instructional challenges for implementing mathematics writing to students who experience learning difficulties, evidence-based practices to address these students' math and writing needs, and a closer look at how constructing written arguments can enhance fraction knowledge and genre knowledge for students with learning difficulties.

INTRODUCTION

Mathematical reasoning and communication involve a combination of mathematical practices and language ability for successful learning (Ball & Cohen, 1990; Boaler, 2016; National Council of Teachers of Mathematics [NCTM], 2000). To engage students in developing their mathematical reasoning, scholars recommend constructing written arguments and critiquing peers' reasoning to facilitate students' learning (Casa et al., 2016). Meta-analyses of studies conducted in the United States and other countries

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have strong evidence to suggest that supporting students' mathematics learning by constructing written arguments in academic contexts enhances learning for students who are 6 to 18 years old in primary, secondary, and post-secondary classrooms (Bangert-Drowns et al., 2004; Graham et al., 2020). Although embedding writing activities has shown to be an empirically effective instructional practice to enhance mathematics learning, few empirical studies have investigated the effects of using written arguments for developing mathematical knowledge and reasoning of students with learning difficulties (Hacker et al., 2019; Kiuahara et al., 2020; Kiuahara, Levin, Tolbert, Erickson et al., 2023; Kiuahara, Levin, Tolbert, O'Keeffe et al., 2023).

This chapter will begin with a brief overview of the language and mathematics difficulties students with learning challenges may encounter when engaging in activities that use writing to learn mathematics. Next, a brief overview of the evidence supporting the genre of argumentative writing to develop students' mathematical reasoning will be presented. Finally, to illustrate how argumentative writing can be used to develop students mathematical reasoning, especially for students with learning challenges, an instructional model will be presented that embeds the explicit teaching of both argumentative writing and mathematical reasoning targeted for students with learning challenges who are 9 to 12 years old and represent Grades 4 to 6 in the United States (Hacker et al., 2019; Kiuahara et al., 2020; Kiuahara, Levin, Tolbert, Erickson et al., 2023; Kiuahara, Levin, Tolbert, O'Keeffe et al., 2023). The mathematics content focuses on learning part-whole and partitioning fractions and foundational concepts, such as comparing the magnitude of two fractions between 0 and 1, equivalence, and measure (Charalambous & Pitta-Pantazi, 2007; Wu, 2011), which aligns with the Common Core State Standards for Mathematics (2010) adopted by many states across the United States. Moreover, combining mathematical practices, such as making sense of problems and preserving when solving them, within an evidence-based instructional framework engages students in the processes of constructing written arguments when learning foundational fraction concepts, supports the learning and attention needs of students with learning challenges, develops their strategic competence and productive dispositions toward learning mathematics, and shows promise for developing the quality of their mathematical reasoning and their fraction knowledge (Hacker et al., 2019; Kiuahara et al., 2020; Kiuahara, Levin, Tolbert, Erickson et al., 2023; Kiuahara, Levin, Tolbert, O'Keeffe et al., 2023).

CHARACTERISTICS OF LANGUAGE AND MATHEMATICS DIFFICULTIES

One in 5 children in U. S. classrooms experience learning and attention challenges, and 6% of students receive specialized instruction under their state's rules and regulations for a specific learning disability (Horowitz et al., 2017). However, the majority of 9 to 10-year-old students across the U. S. are failing to meet proficiency standards in mathematics and writing, including students who qualify for special services and accommodations (National Assessment of Educational Progress [NAEP] for Mathematics, 2013, 2015; NAEP for Writing, 2011). Recent mathematics assessment data collected after the pandemic showed a significant learning loss from 2020 to 2022, which places these students even further behind in mathematics (NAEP, 2022). To effectively teach mathematics writing to students with learning challenges, and because writing and mathematics are cognitively demanding tasks for all students, it is essential to address areas that individual students find challenging when learning and to understand the learning supports students need to engage them in mathematics writing.

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