Chapter 10
A Mathematics Intervention to Engage Elementary Students in Mathematical Writing

Madelyn W. Colonnese
Reading and Elementary Education Department, Cato College of Education, University of North Carolina at Charlotte, USA

Fabiana Cardetti
https://orcid.org/0000-0002-3178-4659
Department of Mathematics, College of Liberal Arts and Sciences, University of Connecticut, USA

ABSTRACT

Mathematical writing is an important yet underutilized mode of discourse. Teachers play an important role in implementing and engaging their students' mathematical writing. However, research on mathematical writing does not offer suggestions for how teachers can engage students in mathematical writing. The purpose of this chapter is to contribute to this area of research by describing how teachers implemented a systematic mathematical writing intervention during a summer school program. The student writing resulting from the intervention demonstrated that students can successfully engage in mathematical writing. Further, students' written work showed key elements of mathematical writing and indicated an understanding of the subconstructs of fraction conceptualization that appeared to be absent prior to the intervention.

INTRODUCTION

Mathematical writing has many benefits for student learning (Graham et al., 2020; Bangert-Drowns et al., 2004). By writing students are able to clarify their mathematical ideas (NCTM, 2000), actively construct knowledge (Cross, 2009), and use mathematically precise vocabulary. Writing also provides students with an opportunity to make their thinking visible thus, allowing students to engage in the metacognitive

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process (Cross, 2009; Pugalee, 2001; 2004). The metacognitive process contributes to students' ability to effectively problem solve, a key skill in mathematics (NCTM, 2014).

Teachers recognize the importance of having students write (Powell et al., 2021) however, writing has continued to be underutilized during mathematics class (Kosko, 2016). Curricular demands, the time needed for writing, and limited instructional support for teachers interested in implementing mathematical writing have contributed to the lack of mathematical writing (Fukawa-Connelly & Buck, 2010). Given the lack of mathematical writing and the importance of this form of discourse, the purpose of this chapter is to describe an example of a systematic mathematical writing intervention. In this chapter we will describe the professional learning that was facilitated to support teacher candidates with mathematical writing and its implementation, details of the intervention, and samples of the resulting student writing.

BACKGROUND

The National Council of Teachers of Mathematics ([NCTM] 2000; 2014) has long called for teachers to engage students in meaningful mathematical discourse that is designed to (a) advance students' understanding of mathematics and (b) engage students in mathematical reasoning. Writing is one way to engage students in such discourse. However; studies of mathematical writing have included a wide variety of definitions, types, and purposes with varied attention to advancing students' understanding of mathematics and engagement in reasoning (Colonnese et al., 2020). For this chapter, we drew from the Elementary Mathematical Writing Task Force to define the purpose of mathematical writing as writing to reason and communicate mathematically (Casa et al., 2016).

In studies of students writing to advance their understanding of mathematics (a), findings have demonstrated that mathematical writing can help to advance students' understanding of mathematics and improves students' mathematical communication skills (Graham et al., 2020; Bangert-Drowns et al., 2004). Further analysis of pre- and post- assessment of students' writing have demonstrated increases in students' mathematics achievement (Cohen et al., 2015; Tan & Graces-Bascal, 2013; Kostos & Shin, 2010; Cross, 2009).

In response to the need for discourse to engage students in mathematical reasoning (b), writing provides students with a way to justify and explain their reasoning (Kramarski & Mevarech, 2003). Students can use writing to both reason mathematically and share their reasoning with others (NCTM, 2000). Because of the permanent nature of writing, students are able to monitor their progress, reflect on, and evaluate their thinking (Graham et al., 2013) – all components of the metacognitive process (Cross, 2009; Pugalee, 2001; 2004).

The metacognitive process is essential in supporting students' development of problem-solving skills (Schoenfeld, 1987). However; researchers have found that explaining mathematical reasoning through writing is often challenging for students (Monoyiou et al., 2006; Kostos & Shin, 2010). For example, in a study of fifth- and sixth- grade students, Monoyiou et al. (2006) found that the students shared their solution but provided no justification or attempted to justify their thinking with numerical examples. This study also revealed that teachers valued reasoning-based justification similarly to justification with numerical examples. Such findings are in line with other research that suggests primary teachers' understanding of mathematical reasoning is often limited (e.g., Stylianides et al., 2006). The limited

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