Chapter 2
Pre–Service Teachers and Mathematics Writing

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ABSTRACT

This chapter focuses upon research related to building pre-service teachers' (PSTs') own competencies in mathematics writing (MW) as well as their skills in teaching MW and integrating MW into their future K-12 classrooms. The authors provide a review of the research with PSTs and MW. Although there is limited research on PSTs and MW, it is likely that many PSTs enter their preparatory programs with limited MW experience and competencies despite expressing beliefs in the value of MW. Therefore, there is a responsibility of mathematics teacher educators (MTEs) to build PSTs' knowledge of the various genres of MW and their purposes, to explicitly teach PSTs to compose high-quality MW themselves, and to provide frequent models of how MW may be integrated into the mathematics classroom across a range of genres. The authors conclude with suggestions for current practice and future research.

INTRODUCTION

Communicating mathematical ideas clearly, coherently, and effectively to teachers, peers, and others, has been a distinct goal of mathematics instruction for over 20 years (National Council of Teachers of Mathematics [NCTM], 2000). Writing represents a common method of communicating mathematical

ideas to others, as well as one's self. Writing plays a critical role in advancing students' mathematical learning by promoting reflection and clarification of ideas through explanations, descriptions, definitions, and critiques (Freeman et al., 2016; Graham et al., 2020; Marks & Mousley, 1990; NCTM, 2000). In addition, mathematical writing (MW), which we broadly define here as any form of writing in or about mathematics, can support students' development of productive dispositions in mathematics while reducing math anxiety (Boaler, 2002; Cobb & Hodge, 2002; Ivanič, 1998; Murphy & Hall, 2008).

MW represents a meta genre (i.e., a genre with several subgenres) with distinctive features and purposes that demand specific knowledge and skill sets of teachers and students (Casa et al., 2016). Research has demonstrated that writing varies distinctly across genres, wherein skills in one genre (e.g., narrative) do not readily transfer to a different genre of writing (e.g., argumentative; Graham et al., 2016), this also applies to MW (Hughes et al., 2020). Therefore, teachers should not expect students to transfer general writing skills to MW but should instead provide MW-specific instruction to support students' MW development. While a growing body of research is expanding our understanding of what MW is (Casa et al., 2016), how MW can support K-12 students (Powell et al., 2017), and the MW practices of current teachers (Powell et al., 2021); little research has focused upon pre-service teachers (PSTs) and MW.

The purpose of this chapter is to describe why research on PSTs is critical to the MW performance of future K-12 students and summarize what we know about PSTs and MW in order to provide guidance to instructors of mathematics methods coursework. These instructors may be responsible for the mathematics education of a PST, whether that be mathematics content knowledge or mathematics pedagogical knowledge. Additionally, we use students throughout this manuscript to refer to K-12 students, including terms like 'future students' to refer to students PSTs will teach once they become in-service teachers, and 'pseudo-students' or 'real students' to distinguish between real and pseudo students when discussing the assessments and activities within our MW module. We begin the chapter with a broad overview of what MW is and what current K-12 practices are. Next, we provide a review of the MW research with PSTs, which includes PSTs' prior MW knowledge and competencies and the impact of MW embedded within mathematics methods coursework with PSTs. Given the limited research with PSTs, we describe a study conducted by the authors that uses an asynchronous MW module to provide an example of how mathematics methods instructors might begin integrating MW within their PST coursework. We conclude the chapter by providing recommendations for current instructors in regards to PSTs as well as provide directions for future research.

Four Types of MW

In MW, students use written composition with embedded visuals and symbols to communicate mathematical concepts. The purpose of MW is to assess student mathematical understanding or develop mathematical understanding (Powell et al., 2021). Students may use four types/subgenres of MW to achieve different communication purposes: exploratory, informative/explanatory, argumentative, and creative mathematics writing (see Casa et al., 2016).

In exploratory MW, students act as their own audience and use writing to make sense of a mathematics concept or problem. Students might write mathematics vocabulary definitions in a journal for their own reference (Bruun et al., 2015) Alternatively, they might engage in pre-writing before they start problem solving. For example, students may complete a written paraphrase of a word problem before solving the problem (Swanson et al., 2019). Although students may regularly practice exploratory writing in the classroom, it is rarely the focus of MW interventions (Powell et al., 2017; Powell et al., 2021).

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