

## Chapter 12

# Formative Assessment and Preservice Elementary Teachers’ Mathematical Justification: Using Digital Tools for Convincing and Assessing

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### **ABSTRACT**

*The focus of this chapter is on elementary preservice teachers’ (PSTs’) use of justification in problem-solving contexts based on a semester algebra course designed for elementary education mathematics minors. Formative assessment and digital tools facilitated the development of PSTs’ understanding and use of justification in algebraic topics. The instructional model used includes the following components: negotiating a “taken-as-shared” justification rubric criteria; engaging in problem solving; preparing, digitally recording, and posting justification videos to the Cloud; and finally, listening and sharing descriptive feedback on the posted videos. VoiceThread was the digital venue for the preservice teachers to listen to their peers’ justifications and post descriptive feedback. Findings from an analysis of a group focus on the PSTs’ peer- and self-feedback as it developed through a semester and the PSTs’ ability to provide a range of descriptive feedback with the potential to promote growth in the understanding and use of mathematical justification.*

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## INTRODUCTION

The importance of justification or proof in the mathematics curriculum is well documented (Kilpatrick, Swafford, & Findell, 2001; National Governors Association Center for Best Practices and Council of Chief State School Officers [NGACBP & CCSSO], 2010; National Council of Teachers of Mathematics, 2000). Stylianides noted, “many researchers and curriculum frameworks have recommended that proof and proving become central to students’ school mathematical experiences in all content areas and at all grade levels...as proof and proving are fundamental to doing and knowing mathematics” (2007, p 289).

Further, the Common Core State Standards for Mathematics (CCSSM) (NGACBP & CCSSO, 2010) includes constructing viable arguments and critiquing the reasoning of others as one of eight mathematical practices for learning mathematics across all grade levels. The authors of the CCSSM suggest that being able to justify *why* a particular mathematical statement is true or where a mathematical rule comes from is a hallmark of mathematical understanding, much different from a student simply recalling a mathematical rule from memory without meaning attached. For example, students may recall how to find the area of a triangle with a base of length  $b$  and a height of  $h$  using  $A = \frac{1}{2}bh$ , but have no idea of why the rule involves multiplication by  $\frac{1}{2}$ . Mathematics classrooms that engage students in mathematical justification “allow students to (a) observe how a rule applies across various cases, (b) construct generalizations to related situations, and (c) reflect on their own reasoning regarding the viability of their rules” (Lannin, Barker, Townsend, 2006).

Given the importance of including justification in the mathematics curriculum, Stylianides and Ball (2008) argued that teachers at all grade levels need opportunities to develop a deep understanding of mathematical justification, if they are to be successful in making this aspect of mathematics an important part of their classroom practices. It follows that similar opportunities should be included in preservice education as well to help the preservice teachers (PSTs) begin to develop an understanding of justification and to consider ways in which they would facilitate this practice in their future classrooms. Kennedy stated, preservice teacher education

*... is located squarely between teachers’ past experiences as students in classrooms and their future experiences as teachers in classrooms. From their experiences, teachers develop the ideas that will guide their future practices. If these ideas are not altered during preservice teacher education, teachers’ own continuing experiences will reinforce them, cementing them even more strongly into their understandings of teaching, and reducing the likelihood that these ideas might ever change. (Kennedy, 1999, p. 57)*

To attend to this recommendation, we focused on the practice of justification in a semester-long algebra course designed for elementary education mathematics minors. At the same time, we were mindful that we were preparing the PSTs to teach in a digital age. The CCSSM (2010) promotes the mathematical practice of strategic use of appropriate tools including the use of digital tools to “explore and deepen (the students’) understanding of concepts” (NGACBP & CCSSO, p. 7). Further, the International Society for Technology in Education Standards (2002) for teachers indicate that they need to be able to model digital age learning. Again, referring back to Kennedy’s (1999) argument stated previously, PSTs need to be involved in experiences that have similar expectations as for current teachers or no change will ever happen in the P-12 classroom, perhaps even more so in the P-12 digital classroom. The use of a Web 2.0 tool, VoiceThread, was incorporated into the course and permitted the PSTs to review and critique their own group justifications as well as observe and critique the justifications of others. We saw the digital

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