PRESERVICE TEACHERS' PERSPECTIVES ON TECHNOLOGY INTEGRATION IN KINDERGARTEN THROUGH EIGHTH GRADE MATHEMATICS

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Studies have highlighted a multitude of beneficial student outcomes associated with the implementation of educational technology. However, there is a lack of understanding in both why and how preservice teachers intend to integrate technology into their future mathematics teaching. This small-scale study sought to examine preservice teachers' (N = 24) perspectives on technology integration within the context of elementary and middle school mathematics. The topics of primary interest in this study was preservice teachers' intended purposes of technology integration. Themes within responses to open-ended prompts were identified and interpreted through the lens of the SAMR model (Puentedura, 2006). Findings show that participants most frequently integrate technological resources in a way that augments a mathematical task. Implications for future research and teacher education are discussed.

Keywords: Technology, Preservice Teacher Education, Teacher Knowledge

The integration of technology into kindergarten through eighth grade (K-8) mathematics has been associated with a variety of benefits to students, teachers, and schools. Though various technological resources exist, particularly popular resources in K-8 mathematics are virtual manipulatives and mathematical games. Virtual manipulatives, defined as "an interactive, Web-based visual representation of a dynamic object that presents opportunities for constructing mathematical knowledge" (Moyer et al., 2002, p. 373), have been shown to increase K-8 students' conceptual knowledge of several mathematics topics (Reimer & Moyer, 2005; Suh & Moyer, 2007), positive attitudes toward mathematics (Lee & Chen, 2015; Sen et al., 2017), confidence in mathematics (Yuan et al., 2010), and feelings of competency (McLeod et al., 2013). K-8 students with disabilities have benefitted from virtual manipulative use as well, demonstrating increased rates of learning (Root et al., 2017), greater accuracy (Bouck et al., 2014), and faster independence (Bouck et al., 2017; Bouck et al., 2018). Mathematical games, such as those offered by Math Playground (https://www.mathplayground.com/), have been shown to increase K-8 students' achievement regarding multiplication (Kiger et al., 2012), adaptive number knowledge, arithmetic fluency, and pre-algebra knowledge (Brezovszky et al., 2019). Technological resources also benefit teachers and schools, as many are free to access, available for use outside of the classroom, and decrease in-class time spent distributing and gathering materials during lessons (Moyer et al., 2002).

Due to these benefits, it is imperative that preservice teachers (PSTs) are competent in technology integration upon degree completion. However, sufficiently preparing PSTs to integrate technology in their future classrooms has proven to be a challenging task for teacher education programs. A common approach implemented by teacher education programs has been adding the requirement of a stand-alone educational technology course – an approach that 85% of institutions have adopted (Kleiner et al., 2007). However, these courses often lack content-specific context and classroom practice opportunities, as just 32% of institutions provide learning experiences where PSTs deliver technology experiences within elementary classrooms (Rose et al., 2017) and many PSTs feel unprepared to effectively integrate technology on their first day of in-service teaching (Tondeur et al., 2012). Research has uncovered several factors that explain PSTs' feeling of unpreparedness, including insufficient access to technology (Dawson, 2008), lack of technology skills (Teo, 2009), negative attitudes toward technology integration, lack of confidence in their ability to integrate

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technology, and the belief that their competence may be undermined due to students potentially having more knowledge about technology (Crompton, 2015). Gaining additional information regarding PSTs' perspectives on technology integration may prove beneficial to teacher education programs, current PSTs, and prospective PSTs.

This study sought to examine PSTs' perspectives on technology integration in K-8 mathematics. The aforementioned challenges associated with PSTs' integration of technology into K-8 mathematics inform the research question in this study: When prompted to select technological resources to enhance K-8 mathematics instruction after a two-day lesson about technology integration in K-8 mathematics, for what purpose do PSTs intend to use the selected resource?

Theoretical Framework

Puentedura's (2006) Substitution, Augmentation, Modification, and Redefinition (SAMR) model offered a theoretical perspective by which the intended purpose of a technological resource may be categorized. The SAMR model highlights four levels in respect to the impact that the integration of technology has on the design of a task within a lesson. Technology acts as a direct tool substitute at both the substitution and augmentation levels, but only provides functional improvement to the task at the augmentation level. The ability to significantly redesign tasks due to technology use occurs at the modification level, and technology use at the redefinition level allows for the creation of new tasks that would otherwise be inconceivable. Within the mathematics context of graphing functions, Dorman (2018) provided examples for each level of the SAMR model:

> At the substitution level, instead of printing off paper copies of the worksheet, an instructor could make the worksheet available online. At the augmentation level, students could complete the same questions on a Google Form, and the instructor could capture the answers for individual students to check for understanding. … At the modification level, … students could work in groups to analyze the different characteristic of functions as they graph them. Then, students could video record the characteristics and steps of how to graph functions. The video could be uploaded to a classroom website so that students can use it as a tutorial or study aid. At the redefinition level, students could create an online portfolio of all types of functions, and their graphs could include real-world applications that are modeled by the functions. (para. 3)

In this study, the SAMR model was utilized as a lens through which PSTs' intended purpose of mathematics technological resources were examined and through which PSTs' understanding of appropriate technology integration were interpreted.

Methodology

This study was conducted at a large university in the Northwest region of the United States. Participants (N = 24) were recruited from a K-8 Mathematics Methods course during the spring semester of 2020, which meets for two, 75-minute periods per week. All participants are PSTs majoring in elementary education which leads to licensure for teaching grades K-8. Participants were asked to respond to several prompts prior to, during, and following a two-day lesson about technology integration in K-8 mathematics. The design of the lesson was informed by Foulger et al.'s (2017) recommendations regarding teacher educator technology competencies and included: (a) an introduction to and exploration of mathematics technological resources; (b) modeling the alignment of K-8 mathematics content with both pedagogy and technology, and (c) collaborative activities in which PSTs designed mathematical tasks which utilized technological resources.

Open-ended prompts were posed to PSTs, including "Find one resource (include the URL) and answer the following questions: (1) For what grade level and CCSS [Common Core State Standards] would the resource be appropriate to use? (2) Explain how this resource might benefit a lesson." at the end of day two and (1) "Locate one resource (include the URL) and describe how you might use this resource to assess understanding in your future classroom." (2) "What do you think is the most practical application of technology in K-8 mathematics, and why?" after PSTs read Johnson et al. (2012) following the two-day lesson. The SAMR model was utilized to investigate the research question, with each response being coded as either substitution, augmentation, modification, or redefinition, according to PSTs' description of how the technological resource would be utilized.

Results

Of the PSTs recruited for this study, 19 consented that their responses may be analyzed for research purposes and 18 successfully completed both prompts. The recruited sample did not allow for an analysis based on demographic factors due to the fact that the vast majority of PSTs in the sample are White females in their third or fourth year of the elementary education program. Thus, demographic information was not gathered in this study.

Intended Purpose of Mathematics Technological Resources

The research question was examined with the following prompts: "Find one resource (include the URL) and answer the following questions: (1) For what grade level and CCSS would the resource be appropriate to use? (2) Explain how this resource might benefit a lesson." and "Locate one resource (include the URL) and describe how you might use this resource to assess understanding in your future classroom." Each response was coded according to the SAMR model based on the capabilities of the technological resource and PSTs' description of how the resource would be utilized in a lesson. In regard to the first prompt, the 18 PSTs who responded demonstrated a strong tendency to integrate technology into K-8 mathematics in a way that provides augmentation (n = 14). Four PSTs integrated technology in a way that modifies the task, while no PSTs described methods of integration where substitution or redefinition are utilized. Similar results were found in relation to the second prompt, in which PSTs favored augmentation (n = 14), while modification (n = 4) and both substitution and redefinition (n = 0) were less prevalent. It is worth noting that a total of 6 PSTs integrated technology in a way that modifies the task in response to at least one prompt.

The left side of Figure 1 displays the Pan Balance applet from the National Council of Teachers of Mathematics' (NCTM) Illuminations collection, which was selected by one PST as an opportunity to integrate technology to teach the commutative property, associative property, and distributive property. The PST supplied the equations located on the left side of Figure 1 and noted that this applet would benefit a lesson due to the visual representation of an equation being either equal to, greater than, or less than another equation. The affordances of the technological resource and rationale provided by the PST classify this instance of technology integration as an augmentation. Functional improvement is present, but a significant redesign of the task due to the integration of technology is not apparent.

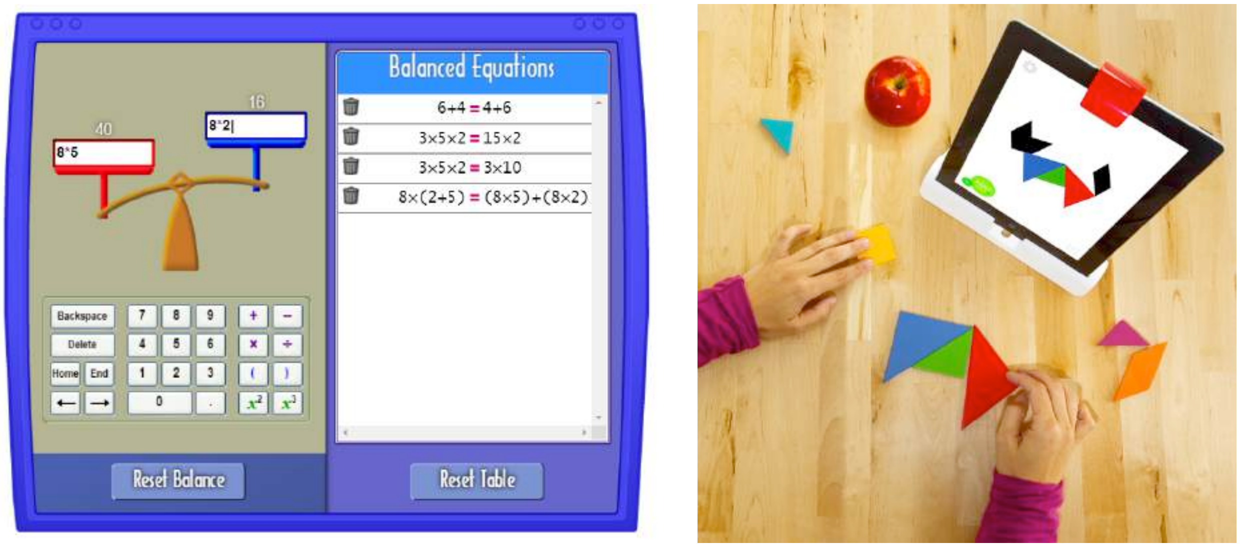

Figure 1: Augmentation - NCTM Illuminations' pan balance applet (NCTM, n.d.) and Modification - Osmo's tangram game (Osmo, n.d.)

The right side of Figure 1 presents the Tangram game to be used in conjunction with Osmo. Osmo, the red-colored device on the top of the tablet on the right side of Figure 1, utilizes the tablet's camera to scan the area directly in front of the tablet and then transfers that image to the tablet's screen. One PST selected Osmo as a technological resource to integrate into K-8 mathematics as a modeling task. The PST noted that Osmo allows for the concurrence of hands-on practice and technology integration in which students might explore the relationships between different shapes and construct/deconstruct various composite figures. The affordances of this game paired with the application described by the PST classify this method of integration as a modification task. The modeling task experiences a significant redesign via Osmo's Tangram game, though implementing this task is not entirely inconceivable without the utilization of the game via Osmo.

Discussion and Implications

Findings in regard to the research question are highlighted by PSTs' tendency to select and describe the integration of technological resources that augment a mathematical task. Similar results were found by Cherner & Curry (2017) when examining preservice English and social science teachers. While there is limited research of this topic within the context of mathematics education, this study uncovers a degree of understanding regarding PSTs' intended purposes of technology integration in a K-8 mathematics setting. These findings also have potential implications in regard to teacher education. The SAMR model was not presented to PSTs in the K-8 Mathematics Methods course, so it is possible that PSTs are simply unaware of the various degrees to which technology integration can impact the quality of a mathematical task. How might we encourage our PSTs to more frequently integrate technological resources in ways that modify and/or redefine the mathematical task? Future research is needed to examine the relationship of both the exposure to and discussion of the SAMR model to PSTs' design of mathematical tasks that utilize technological resources.

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