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Examining pre-service elementary mathematics teachers' reading of educative curriculum materials

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HIGHLIGHTS

- An investigation of pre-service teachers' (PSTs) reading of elementary mathematics educative curriculum materials.
- PSTs tended not to read educative curriculum materials in potentially educative ways.
- Other ways that PSTs read curriculum materials included descriptive, evaluative, interpretive, and adaptive.
- This study has significant implications for curriculum developers, researchers, and mathematics teacher educators.

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ABSTRACT

Educative curriculum materials are intended to support teacher learning. An assumption underlying the design of educative curriculum, however, has been that teachers will read features that are designed to be educative in educative ways. This study investigated what text features 47 preservice teachers (PSTs) attended to in their reading of 5 mathematics lessons from Standards-based curriculum series and how they read those features. We found that PSTs tended to not read educative text feature in potentially educative ways and instead read them in other ways (e.g., descriptively). This study has significant implications for curriculum developers, researchers, and mathematics teacher educators.

1. Introduction

In many countries, curriculum materials are one of teachers' primary resources for enacting instruction. Regardless of subject area, or whether curriculum standards and policy are set at the national level (Schmidt, Wang, & McKnight, 2005) or at the state, district, or school level as in the United States (US), teachers must utilize curriculum materials in effective ways. Learning to mobilize curriculum in a manner that supports student learning is not a trivial task, especially for early career teachers. This issue is especially problematic in the US as teacher mobility between states and/or districts, the implementation or revision of National (CCSS, 2010a; 2010b) and State standards (e.g. SCDOE, 2015), the vast abundance of curriculum materials and resources available through publishers and online, and the cycle of "textbook adoption" mean US teachers of all subjects and grade levels will need to learn to mobilize curricula that are unfamiliar to them on multiple occasions throughout their career.

One way curriculum designers and researchers in mathematics and science have attempted to support teachers' ability to mobilize curriculum is to design curricula to be educative, as in Ball and Cohen (1996), Davis and Krajcik (2005), and Drake, Land, and Tyminski (2014). For example, Krajcik and his colleagues' work in Project-based Science (Krajcik, Blumenfeld, Marx, & Soloway, 1999; Marx, Blumenfeld, Krajcik, & Soloway, 1997); Arias and her colleagues' (Arias, Bismack, Davis, & Palincsar, 2015) work with *Science and Technology for Children* (National Science Resources Center, 2004); Cervetti, Kulikowich, and Bravo's (2015) work to support English language learners, and the mathematics curricula *Investigations in Number, Data, and Space* (TERC, 2008) *Everyday*

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Mathematics (UCSMP, 2007), and *Connected Mathematics* (Prentice Hall, 2006) each have embedded educative features. Educative curriculum materials are intended to support teacher learning in addition to student learning. For example, educative curriculum materials can support teachers in learning subject matter or in learning how to anticipate children's thinking (Davis & Krajcik, 2005). An assumption underlying the design of educative curriculum, however, has been that teachers will read features that are designed to be educative in educative ways. They will understand that the information provided in curriculum materials is designed for their own learning, and they will read the features from that perspective.

Reading, evaluating, and adapting are three key ways that teachers interact with curriculum materials (Sherin & Drake, 2009). Though each modes of interaction is important and interrelated, we posit that without effective *reading* of curriculum materials, there is little chance that teachers can effectively evaluate and adapt them. "Reading is the intellectual process most closely connected to teachers' curriculum decisions. Thus, change in the enacted curriculum must occur through change in how or what teachers read" (Remillard, 1999, p. 338). Our work is with elementary pre-service mathematics teachers (PSTs) and little is known about how PSTs read educative curriculum materials. In order to support PSTs in reading and using curriculum materials in educative ways, we must first understand which features they attend to and how they attend to them.

In this exploratory study, we analyzed PSTs' reading of five mathematics lessons from *Standards*-based[1] curriculum series to answer our research questions, "Which lesson features of educative curricula do PSTs identify as important?" and "How do PSTs read those features?" Understanding PSTs' patterns of attention when reading curriculum materials is essential due to the ubiquity of mathematics curriculum materials in elementary schools (Remillard, 2005) and because PSTs struggle with gaining the needed skills for teaching (Jacobs, Lamb, & Philipp, 2010; Morris, Hiebert, & Spitzer, 2009). *Standards*-based curriculum materials can serve as scaffolds for PSTs' acquisition of these skills (Drake et al., 2014).

2. Literature review

We begin by examining research on educative curriculum materials (Ball & Cohen, 1996; Davis & Krajcik, 2005; Drake et al., 2014). Research around teachers' use of educative curriculum materials spans multiple content areas, including mathematics, science, literacy, and physical education. We also draw from research conducted by Remillard (1999, 2000) and Sherin and Drake (2009); Drake and Sherin, (2009) pertaining to teachers' reading of curriculum materials for elementary mathematics. Due to the relative lack of research focused on PSTs, we rely primarily on the research involving practicing teachers. Finally, we discuss research in mathematics and science education addressing supports for PSTs. We include this knowledge base as it provides examples of the various ways in which researchers have supported PSTs in their reading of curriculum materials.

2.1. Educative curriculum materials

In a conventional elementary mathematics curriculum, the teacher's role is minimalized in that the materials are perceived as agents that could function without the teacher (Ball & Cohen, 1996). A mathematical idea is "covered" approximately every two pages of the text and a given lesson often consists of discrete facts, definitions, examples and/or procedures for the teacher to present. Students are expected to demonstrate through practice exercises that they have assimilated the ideas presented to them, precisely as they were explained or demonstrated. Because teachers are often very familiar with the format and approach of conventional textbooks, these texts typically do little to challenge the knowledge, beliefs or attitudes teachers hold in mathematics. Remillard (2005) writes that traditional curriculum materials "speak through the teacher" (p. 252), leaving few opportunities for teachers to engage in thought about teaching ideas.

In contrast, Ball and Cohen (1996) proposed designing curriculum materials to support teacher learning as well as student learning. In their view, curriculum materials were "well positioned to influence individual teacher's work" (p. 6), could be designed to "place teachers in the center of curriculum construction and make teachers' learning central to efforts to improve education" (p. 7), and could "contribute to professional practice" (p.7). Building on Ball and Cohen's ideas, Davis and Krajcik (2005) presented a series of five "high level guidelines" describing the roles educative curriculum could play in promoting teacher learning. These guidelines posited curriculum materials could be designed to: 1) support teachers' development of pedagogical content knowledge (as in Shulman, 1986) including "how to anticipate and interpret what learners may think about or do in response to instructional activities" (p. 5); 2) support development of teachers' subject matter knowledge; 3) "help teachers consider ways of relating units during the year" (p. 5); 4) "make visible the developers' pedagogical judgments" (p. 5); and 5) "promote teachers' pedagogical design capacity" (p. 5) (as in Brown & Edelson, 2003).

Standards-based curriculum series such as *Math Trailblazers* (UIC, 2008), *Investigations in Number, Data, and Space* (TERC, 2008) and *Everyday Mathematics* (UCSMP, 2007) are examples of elementary mathematics curricula that reflect the calls of Ball and Cohen and Davis and Krajcik, and include specific educative features. We also recognize that these types of curriculum materials may "influence teacher's work" and "contribute to professional practice" in ways that are not necessarily educative in terms of the high level guidelines proposed by Davis and Krajcik. That is, curriculum materials can support teacher learning in general ways, especially when considering the development of prospective and early career teachers' practice. For teachers who have minimal classroom experience, educative curriculum materials can also support teacher learning in non-subject specific ways through their organization and representation of pedagogy.

Reading *Standards*-based mathematics curriculum materials however, is different than reading conventional materials. In *Standards*-based lessons, teachers are expected to act as facilitators and problem posers; and students are expected to develop the mathematical ideas and solution paths to solve problems with support from the teacher. There are often fewer problems and although answers are provided in the Teacher's Guide, the Guide also often contains other information intended to support both students and teachers. We refer to the information included to support teacher learning as the *educative features* of a curriculum.

Some common educative features found in *Standards*-based curriculum materials include potential questions to pose, examples of student thinking or misconceptions, possible solution paths, observational assessment strategies, and approaches for differentiation. Each of these features needs to be understood and interpreted by the teacher, and also in terms of past and future lessons, as ideas are intentionally developed and connected within and

[1] In using the term *Standards*-based curriculum, we are referring to the curriculum materials funded by the National Science Foundation and aligned with the NCTM Standards (1989, 2000), including: *Investigations in Data, Number and Space* (TERC, 2008); *Everyday Mathematics* (UCSMP, 2007); and *Math Trailblazers* (UIC, 2008). We also note that these curriculum materials are intended to be educative in nature.