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Elementary mathematics specialists in "departmentalized" teaching assignments: Affordances and constraints☆

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ABSTRACT

In this article, we describe the experiences of three Elementary Mathematics Specialists (EMS) who were part of a larger project investigating the impact of EMS certification and assignment (self-contained or "departmentalized") on teaching practices and student achievement outcomes. All three of the teachers were "departmentalized," in the sense that each was responsible for teaching mathematics to at least two groups of students, and accordingly, did not teach all subjects as would a typical self-contained elementary teacher. Each teacher had recently earned an Elementary Mathematics Specialist certificate through completion of a 24-credit, graduate-level program designed to build pedagogical content knowledge and leadership capacity in mathematics. Through a series of observations and interviews over the course of one school year, we examined how the teachers described and navigated specific affordances and constraints they encountered in their particular contexts. Common affordances included opportunities to revise and learn from instruction, and constraints included reduced flexibility introduced by the need to schedule multiple classes of mathematics. Despite these common features, we found important differences between the three models of departmentalization, which we describe as *team approach*, *class swap*, and *grade-level mathematics teacher*. For example, some of the models provided more opportunities for collaboration while others made it difficult for teachers to address potential inequities in learning opportunities across sections. Despite the constraints of their respective models, we found evidence of the EMS-certified teachers drawing on professional expertise in mathematics to meet student needs.

1. Introduction

Research has clearly established the importance of deep, connected, topic-specific knowledge for teaching elementary mathematics (Campbell et al., 2014; Copur-Gencturk, 2015; Hill, Blunk et al., 2008; Hill, Rowan, & Ball, 2005). One significant problem not yet solved is how to provide all students with access to teachers who have and can use this specialized knowledge in their practice. Most undergraduate elementary teacher preparation programs in the United States fall well

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short of the 12 h of recommended coursework for effective preparation in mathematics teaching (Conference Board of the Mathematical Sciences, 2012). Although there are successful professional development programs that engage teachers in developing mathematical knowledge (e.g., Hill & Ball, 2004; Koellner et al., 2007), these are expensive and time-consuming, with relatively limited reach and longevity.

An alternative strategy for providing access to high-quality mathematics teaching is to train some elementary teachers as Elementary Mathematics Specialists (EMS). In the United States, 19 states currently have, or are in the process of developing, certification guidelines for EMS (http://www.mathspecialists.org), which generally involve graduate-level coursework aligned with a set of standards established by the Association of Mathematics Teacher Educators (2013). These programs support EMS-certified teachers in developing deep and connected knowledge of mathematics content and pedagogy.

Although EMS are currently used in a variety of roles (Fennell, 2011), some experts have called for research on the use of EMS as classroom teachers, particularly in "departmentalized" settings, where they teach mathematics to multiple classes of students (McGatha, 2009; National Mathematics Advisory Panel, 2008; Wu, 2009). The idea of having elementary teachers assigned to content-specific teaching roles is hardly new (Otto, 1931; Slavin, 1987), but previous efforts to study the impact of departmentalization have not involved teachers with particular expertise or training in their specialized subject area (McGatha, 2009). Instead, teachers were assigned to such roles based on the principal's discretion, personal preference, or a process of turn-taking.

In this article, we describe a set of three cases documenting the intersection between specialized mathematics assignment and EMS certification. We examine how three EMS-certified teachers, all of whom were participating in a larger study investigating the impact of both EMS certification and departmentalized assignment on teaching practice and student achievement, described and navigated the constraints and affordances of departmentalization. We focus on the day-to-day work of teaching in a departmentalized setting, highlighting ways that different contextual factors can either support or hinder EMS-certified teachers in continuing to build and apply their expertise in mathematics teaching. We discuss implications for administrative decision-making and offer suggestions for future research on departmentalization at the elementary level.

2. Theoretical framework, literature review, and context

In this section we describe our theoretical perspective on teaching and learning to provide a rationale for why EMS-certified teachers might be well suited for a specialized role teaching multiple sections of mathematics to students. This includes not only why they would be effective mathematics teachers, but also how departmentalization might allow them to optimize and refine their expertise in mathematics teaching.

2.1. Theory of learning and teaching

Our perspective on teaching is rooted in the theory of constructivist learning—that students construct understandings by assimilating or accommodating new knowledge into existing cognitive structures rather than passively absorbing knowledge from external sources (Steffe & Gale, 1995). While constructivism does not supply a theory of teaching, it does cast the teacher's role in particular ways (Simon, 1995). As described by Koellner et al. (2007), teaching under a constructivist philosophy can be conceived of as "a dynamic process of inquiry into student reasoning rather than a process of transmitting a set of procedures" (p. 274).

This view of teaching as *inquiry into student reasoning* implies that the most effective teachers are those who know the most about how students' mathematical understandings develop and how this development can be supported (Sztajn, Confrey, Wilson, & Edgington, 2012). This idea finds grounding in the notion of *pedagogical content knowledge* (Shulman, 1987), which posits that effective instruction requires more than knowledge of the content to be learned and more than knowledge of general pedagogy; instead, knowledge of content and pedagogy are intertwined. In mathematics, much theoretical work has been done to further define *mathematical knowledge for teaching* (MKT), including a breakdown of both content knowledge and pedagogical content knowledge into finer-grain categories (Hill, Ball, & Schilling, 2008). These frameworks have been supported through empirical research showing that MKT is a construct independent of other characteristics of teachers (Hill, 2010), can be developed through professional development (Hill and Ball, 2004), and relates to improved student learning outcomes (Hill et al., 2005) and teaching practices (Hill, Blunk et al., 2008).

These findings are similar to an earlier program of research, Cognitively Guided Instruction (CGI), a professional development project that focused intently on developing teachers' knowledge of student thinking in elementary mathematics (Carpenter, Fennema, Franke, Levi, & Empson, 2000). This work also yielded significant improvements in teaching practices and student learning outcomes (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Fennema et al., 1996; Fennema, Franke, Carpenter, & Carey, 1993). More recent research has also confirmed links between teacher's pedagogical content knowledge, their teaching practice, and student achievement outcomes (Campbell et al., 2014; Copur-Gencturk, 2015).

2.2. PCK and elementary mathematics specialist programs

Programs that prepare elementary mathematics specialists are designed to support the development of MKT (de Araujo, Webel, & Reys, in press). They are generally aligned with the Association of Mathematics Teacher Educators' Standards

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