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Coaching teachers to implement innovations in STEM

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HIGHLIGHTS

- A STEM Coach was an effective tool to support teacher agency in implementing STEM.
- Addressing the needs of individual teachers led to targeted and timely supports.
- The STEM coach role was co-constructed and required the coach to learn as she went.
- Educators prioritize coach roles that decrease work over those that support STEM.
- A balance of generalized and targeted supports met individualized needs.

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ABSTRACT

STEM is evolving as a discipline and includes challenging educational practices. Teachers need support to address these challenges and implement STEM. We present an intervention in which a STEM coach supported teachers implementing STEM across a school district. The coach role was valued for (1) connecting to outside resources, (2) teaching teachers and students, and (3) planning STEM initiatives. Educators accessed the coach to improve their practice, comply with or advance the STEM initiative, or avoided the resource. Educators used the resource to distribute their workload. These actions and perceptions informed how the role was co-constructed throughout its launch year.

1. Introduction

STEM as an academic discipline is not well defined (Bybee, 2013; Koehler, Binns, & Bloom, 2016). As it has evolved, it has become more than a vehicle to ensure the teaching of Science, Technology, Engineering and Math. In many instances STEM has come to imply a deep integration of the disciplines within the acronym as well as art/design, language arts, and the social sciences. The STEM label is also often associated with integrated curriculum (Johnson, Peters-Burton, & Moore, 2016), project- or problem-based learning (Tawfik & Trueman, 2015), inquiry methods (Crippen & Archambault, 2012), place-based or community-engaged curriculum (Vennix, den Brok, & Taconis, 2017), and otherwise contextualized curriculum (Giamellaro, 2017). Many envision STEM as a vehicle to advance equity in education (Peters-Burton, Lynch, Behrend, & Means, 2014; Rodriguez, 2016). In other words, STEM has quickly become an amalgam of many of the most promising but difficult to implement ideas in education.

How then can a teacher, school, or district navigate these disparate ideas within the existing constraints of public education to effectively enact STEM with students? For educators, the ambiguity may be enough to dissuade adoption of a STEM approach (Hall & Hord, 2015). To implement broad scale STEM, the field needs mechanisms to help teachers find and use effective practices and resources that are at once targeted and amenable to the ambiguity. Because STEM seems to be built from other ideas of progressive education, these mechanisms are germane to the education landscape beyond STEM as well.

Abbreviations: EDP, Engineering design process; NGSS, Next Generation Science Standards; PBL, Project-based learning; PD, Professional development; RPP, Research-Practice Partnership; STEM, Science, Technology, Engineering, Mathematics.

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We describe one mechanism used by a Research-Practice Partnership (RPP; Coburn, Penuel, & Geil, 2013) to launch STEM curriculum and practices across a rural school district in the United States. An RPP is an evolving, long-term, and mutualistic partnership, focused on addressing problems of practice, that has research and dissemination value, and that shows continual strengthening of the partnership (Coburn & Penuel, 2016). This RPP utilized a STEM coach to support teachers across all grade levels (K-12) and academic disciplines to create and implement STEM curriculum that was student-centered and situated within the community outside of the school. These goals were collectively established by the consortium of teachers, administrators, and researchers before the launch of this school change initiative. In this study, we examine the evolution of the STEM coach role, focusing on how educators perceived and co-constructed the role. We aimed to build and test a system that was effective for this school district and that would have elements with potential for export to other schools.

1.1. Theoretical perspective

Taking a cultural-historical activity theoretical approach (Severance, Penuel, Sumner, & Leary, 2016), we consider (1) the coach role as a mediating tool that would help individuals and the system achieve the goal of integrating STEM into the classroom and (2) that this role is co-constructed by all actors within the system. Mediating tools are constructs, objects, symbols or other devices that people can use to enhance performance beyond what is possible without the tool (Gee, 2008). As with all tools, they become such through use rather than design, they are socially shared, and they can be co-opted for new purposes (Wertsch, 2007).

Tools, like other innovations, are actively constructed, even through resistance, by the participants as they each bring their own experiences and meanings to the process and appropriate the innovation for their own use (Rogers, 2003). Thus, there are multiple realities experienced by the participants who each have their own knowledge and perspective, rather than a singular, objective reality (Charmaz, 2006). Because all of the actors are working within the same system, they not only appropriate ideas for themselves but they also influence the development of the innovation as a whole (O'Neill, 2016). Through use in their specific context, educators co-construct an innovation. With these theoretical assumptions in mind, we studied the STEM coach role as it developed in real time, focusing on the perspectives of the people who helped to shape the role.

1.2. The systemic approach to STEM in crawford

This RPP began as a conversation around implementing STEM in Crawford Schools (a pseudonym) with the support of the authors' university. Over time the RPP expanded to acquire grant support and additional partners to undertake a significant school change initiative through district-wide STEM. Members of the RPP met weekly to discuss the logistics and quarterly for strategic planning. Once hired, the STEM coach participated in these meetings. In keeping with the design-based research approach of an RPP (Coburn & Penuel, 2016), incoming data led to decisions on aspects of the STEM initiative to introduce, keep, bolster, or phase out.

The Crawford vision for STEM mirrored the tenor of the international STEM conversation through disciplinary integration. The model also reflected the notion of inclusive STEM (Rodriguez, 2016) through the insistence that STEM opportunities be available to all students. This school change process asked teachers to reach beyond their well-established pedagogical practices and curriculum, and to integrate STEM content that was unfamiliar to many of them. As such, it was clear that the process would be daunting and would require extensive support.

In response, the RPP created supports for teachers including university coursework, ongoing professional development (PD), and paid release time for planning, as well as changes to school systems and schedules. The university team implemented a series of PD events including introductions to STEM and Project-Based Learning (PBL), week-long summer institutes, and graduate courses for teachers to intensively explore STEM curriculum. These supports were designed to work together based on the characteristics of high-leverage teacher PD: (1) content-focused, (2) internally coherent and aligned to other school initiatives, (3) of extended duration with continuous feedback, (4) active learning and modeling of effective teaching practices, (5) collective participation, and (6) an individualized approach that meets the needs of each educator (DeMonte, 2013; Desimone, 2009; Johnson & Sondergeld, 2016). Despite the many supports, the RPP agreed that the teachers would benefit from the day-to-day support of a STEM coach who could provide the ongoing support called for in the PD literature (Johnson & Sondergeld, 2016).

In order to increase the available STEM expertise within the school community and to build both relevance and student engagement, the initiative depended heavily on direct involvement with local experts, agencies, businesses, and places. Before the launch year, teachers indicated that they most wanted support with connections to these outside resources and with converting their practices to PBL. To achieve the vision of school being tightly integrated with the community required a commitment of time and outreach expertise, a role to be filled by the STEM coach.

1.3. The STEM coach model

While we did not find any existing research on STEM coaching when designing this support, the broader body of work on instructional coaching was instructive. We relied on a literature base describing instructional coaching in language arts, mathematics, and science. Broadly, instructional coaches tend to occupy a social and systemic niche that requires them to cross boundaries, at times with much difficulty (Hopkins, Spillane, Jakopovic, & Heaton, 2013). In so doing, however, they are positioned to leverage a significant effect on a school system in change (Hopkins et al., 2013). Coaches are often hired as expert teachers but must learn a new skill set in practice and these skills are often affective (Hunt, 2016) as well as pedagogical or content-focused (Bengo, 2016). Most instructional coaches transition from being classroom teachers to a perceived elevated status, and serve as ad hoc mediators between faculty and administration (Gallucci, Lare, Yoon, & Boatright, 2010) or between schools and external policies (Kintz, Lane, Gotwals, & Cisterna, 2015).

Directive coaching models, those in which the coach delivers expertise to teachers, can establish a hierarchy that limits teacher agency, and this approach tends to serve external rather than classroom concerns (Crafton & Kaiser, 2011; Hibbert, Heydon, & Rich, 2008; Sailors & Price, 2015). These conditions can create a scenario in which the coach's work is heavily scrutinized by stakeholders at all levels while the coach is also trying to develop an entirely new set of professional skills (Gibson, 2005). Instructional coaches often find themselves working against teacher belief systems, in potentially hostile school cultures, and under unrealistic expectations to be the singular tool for reform agendas within schools (Gallucci et al., 2010; Lowenhaupt, McKinney, & Reeves, 2014; Obara, 2010). With these barriers, instructional coaches often struggle as they transition from classroom teacher to teacher of their peers (Gibson, 2005). They also tend to wrestle with new identities, methods, ambiguous expectations, and shifts in how