Mathematics Specialists as the Hidden Players in Professional Development: Researchable Questions and Methodological Considerations

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Abstract

This paper suggests implications for researchable questions about mathematics teacher development. We ask the following: what is necessary for research that includes mathematics specialists or other hidden school-based roles within a project beyond classroom teachers and students? Mathematics specialists (e.g. mathematics coaches, mathematics teacher leaders) support teacher learning and development using different models of school-based professional development. They can play a critical role in connecting research and practice. However, research in mathematics education has regularly neglected to examine their role in studies of professional development. We suggest there are two needs for creating and examining researchable questions about such hidden players in studies of professional development: (1) defining practices and hidden players involved in systematic school change and (2) identifying the unit of analysis and scaling up professional development. We summarize existing studies and present considerations for future research.

Keywords Mathematics specialists · Professional development · Research design · Teacher development

As mathematics teacher educators, we are tasked with “setting research agendas based on instructional problems teachers want to solve” (Cai et al., 2018, p. 514). Targeted research agendas are especially critical for mathematics teacher professional development, as the context and partnerships between universities, schools, and other organizations are often reflected within the types of instructional problems we investigate.

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Within each of these unique partnerships exist complex relationships that must be addressed as we strive to better connect research and practice to influence teacher learning and student outcomes. Researchers and school stakeholders alike possess questions about the effectiveness of existing professional development models and whether or not these models are supporting or sustaining changes in teaching practice. Simultaneously, there are initiatives centered on equity, STEM integration, the changing landscape of curriculum use (Polikoff, 2018), and online teaching technologies. These factors are not only influencing district- and school-level educational policies and practices but also dynamically changing the content and modalities available for professional development. Additionally, despite large-scale professional development efforts over the last quarter century, the standard reform movements in mathematics and science appear stagnant, with mathematics in particular continuing to be taught in isolation with an emphasis on rote skills and memorization (National Academy of Engineering and National Research Council, 2014).

Cai et al. (2017) argue that professional development implementations should continually center on improving teacher practice and involve “an ongoing cycle of defining learning goals, creating learning opportunities, and improving them by monitoring their effectiveness in real classrooms” (Cai et al., 2017, p. 346). If we are to improve preK-12 teacher practice to influence student learning outcomes in ways that we have not yet accomplished, we must reflect on our own actions as researchers and adjust the way we investigate and report on school partnerships. In looking at past research, when we align the various teacher roles captured in research with those roles within preK-12 classrooms, several key school stakeholders are continually missing from the compilation of narratives of this work. Administrators, specialists, and other instructional support personnel are influential to the success and sustainability of every professional development, yet rarely do we capture their insight or perspective as part of the systemic change within a classroom. In this paper, we refer to these individuals as hidden players. These school stakeholders not only support classroom instruction via planning and resources but also provide onsite, ongoing professional development at the school while implementing district- or school-wide initiatives. These players greatly influence the classroom context and, in some instances, the overall landscape of a school. The credentials of these individuals are varied, possessing content specialization, additional licenses or endorsements, and a wealth of professional experience. Each of these hidden players is working on the ground within school settings, with the common goal of making instructional shifts to help all teachers and students succeed.

Throughout mathematics education research, there are several common characteristics of impactful mathematics professional development including addressing problems of practice, providing ongoing interaction, responding to teachers’ needs, and providing opportunities for engagement in reflective cycles (Cobb & Jackson, 2015; Even, 1999, 2005; Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010). Many common models of impactful professional development rely on small, school-based groups of teachers to engage in professional learning such as professional learning communities (Horn & Little, 2010), lesson study (Lewis, 2016), or math lab (Kazemi et al., 2018): for a common purpose such as examining students’ mathematical thinking (e.g. Hiebert, Morris, Berk, & Jansen, 2007; Herbel-Eisenmann & Phillips, 2008) or planning mathematical tasks (Lewis & Hurd, 2011). Other models include individual coaching in which a teacher and instructional leader, such as a mathematics specialist,

collaborate to bring evidence-based practices into preK-12 classrooms (Chval et al., 2010; Cobb & Jackson, 2015; Even, 1999; Gu & Gu, 2016). While some evidence exists of success enhancing instruction and influencing student learning within these specific professional development models (Borko, Jacobs, Koellner, & Swackhammer, 2015; Koellner, Jacobs, & Borko, 2011; Lewis, 2016; Lewis & Perry, 2014), missing from many empirical studies is understanding the role and importance of school-based facilitators such as mathematics specialists. If it is our aim, as mathematics education researchers, to investigate the influence of the professional development within school settings, it is essential to better understand the school-based teacher leadership that is providing the ongoing professional development within the school context when researchers are not present.

In this paper, we focus on mathematics specialists as both one example of a hidden player within schools that has been neglected in prior research and as an exemplar for challenges in researchability in professional development for our communities. In doing so, we specifically use the mathematics specialist role to highlight the generalizable challenges we must address as researchers if we truly want to examine and influence teacher practice. We discuss researchable questions for teacher professional development from two directions. First, what can become researchable if mathematics specialists are included in research? Second, what is necessary for research that includes mathematics specialists or other hidden school-based roles within a project beyond classroom teachers and students? In our discussion, we center on two challenges that are essential for researchers of all content areas to address as they design, implement, and report on professional developments: (1) defining practices and hidden players involved in systematic school change and (2) identifying the unit of analysis and scaling up professional development. These challenges are particularly salient for research that may be large scale, which include complex partnerships with multiple schools or districts, or in later categories of research, such as impact, effectiveness, or scale-up, where persons beyond the initial developers are using resources and tools from earlier design stages (USDOE & NSF, 2013).

Challenge No. 1: Creating Operational Definitions and Identifying Hidden Players

In designing research-based professional development, a challenge for researchers is first to “pose significant questions that can be investigated empirically” (National Research Council [NRC], 2002, p. 3) and to provide guidance that “helps researchers develop significant questions” (Cai et al., 2019, p. 114). The professional development needs to be responsive to the complex and varied local settings and provides enough detail for other researchers and practitioners to replicate or apply. Yet at times, written research reports utilize terminology or vocabulary that is ill-defined or has multiple interpretations of implementation. This results in non-replicable research and adds to the disconnect between research and practice.

For example, co-teaching is a model for instruction and professional development described in a variety of research, yet often with little details as to the method of implementation. Despite a common definition across researchers, “implementation of co-teaching is often operationalized more broadly” which results in vast variability

across implementations (Solis, Vaughn, Swanson, & Mcculley, 2012, p. 499). In some models, the primary classroom teacher maintains all responsibility for instructional planning and delivery, and in other models, the students are split across two or more teachers. In each model of co-teaching, there are different levels of participation and responsibility from those involved. Furthermore, like co-teaching, departmentalized elementary teaching (Markworth, Brobst, Ohana, & Parker, 2016) has multiple models of instruction and frequently involves more than just the classroom teacher. In these cases, there are many ways in which the planning for departmentalization might occur: a team could divide and delegate subjects across either one or more grade levels, a content specialist could provide weekly professional development with targeted resources to all team members, or a partnership might exist between two or more teachers in which they collaboratively take on the content planning for the remainder of the team.

Baker, Bailey, Larsen, and Galanti (2017) highlight challenges connected to the vagueness in descriptions of the varying levels of involvement and participation within an analysis of mathematics specialist literature. They suggest the development of a common vocabulary and descriptions within all research so that terms such as mathematics specialist and co-teaching are discussed in ways that are replicable. In this manner, details that connect a specific practice to learning and teaching outcomes would serve as evidence of efficacy, give support to practitioners aiming to implement new strategies, and provide guidelines for professional learning experiences in research. To be responsive to this complexity in local settings, research questions need to incorporate definitions of the roles of hidden players and initiatives. In each of the examples, there exist hidden players who are potentially influential on a teacher's classroom instruction, yet at times not accounted for within the research. To respond to problems of practice, research questions need to account for these variations in roles and responsibilities of teachers and other staff.

Mathematics Specialists as an Exemplar. There are a variety of titles, roles, and responsibilities of mathematics specialists, and as such, mathematics specialists can be situated in schools or districts as (1) mathematics teachers whose primary responsibility is to the K-12 classroom (Webel, Conner, Sheffel, Tarr, & Austin, 2017); (2) mathematics interventionist whose primary responsibility is to provide support for students; or (3) mathematics coaches whose primary responsibility is to work with teachers and other school stakeholders. As classroom teachers, there is also variation in how that work is defined at the elementary level. For instance, Markworth et al.' (2016) study points to multiple models where the elementary mathematics specialists might work with one or more teachers to instruct the same group of students. In this paper, we use McGatha and Rigelman's (2017) definition in which a mathematics specialist is an individual with expertise in mathematics teaching and learning who is responsible for the leadership of other teachers. We selected this definition because the role we are interested in for research about professional development is their work with teachers more than students.

Mathematics specialists provide the everyday leadership and support for preK-12 school initiatives, as well as an essential connection between school administrators and classroom teachers (Fennell, 2017). There are currently 20 states that recognize the need for mathematics specialists through specific licensure or certificate routes

(Spangler & Ovrick, 2017), and of the 7940 elementary schools surveyed in the 2013 National Association of Educational Progress (NAEP) report, 3010 (38%) had a full- or part-time mathematics specialist (Harbour, 2015). Despite the fact that over one-third of elementary schools reported having an individual within their school responsible for mathematics instruction, in a 2015 National Council of Teachers of Mathematics Research Brief, McGatha, Davis and Stokes identified only 24 research-based articles that spoke of this particular hidden role and provided empirical evidence of mathematics specialist work, expectations, experiences, and relationships. So, these individuals exist in schools but appear hidden in the research.

Given the varied ways that mathematics specialists work in different settings, a challenge for research is understanding how their work in one study might inform future studies. Creating operational definitions (Lesh & Clarke, 2000) to support research involving mathematics specialists is a key component of making professional development researchable. The operational definition should describe the environment the specialist is working within and the kinds of activities they are responsible for doing, and consider what characterizes success in those situations. The operational definition then supports later stages in the process (e.g. defining the unit of analysis, structuring evidence). Since a mathematics specialist is likely to encounter resistance or barriers when advocating change (Larsen, 2012; Woulfin & Rigby, 2017), it is important to consider that sustained change requires a long-term perspective (Campbell & Malkus, 2011). To increase the effectiveness, it is essential to consider the length of time a mathematics specialist will be employed so that school stakeholders can develop long-term goals advocating for systematic instructional change and/or short-term goals providing small, measurable successes that serve as milestones. When a clear structure and purpose for mathematics specialists in professional development are lacking, the research lacks generalizability because it is unclear whether the role of the mathematics specialists in one setting is the same as in another setting and how. As discussed previously, mathematics specialists are used within this paper as an exemplar of the many hidden players in which operational definitions of roles and responsibilities would benefit researchers and practitioners alike.

Challenge No. 2: Identifying the Unit of Analysis and Scaling Up Professional Development

Inherent to the dynamic and responsive nature of their work, research-practice partnerships have challenges (Penuel, Fishman, Cheng, & Sabelli, 2011), and further research is required about how to effectively carry out these partnerships in different settings. Specifically, Cobb and Jackson (2011, 2015) describe the challenges inherent in scaling up an innovation for students' learning and the need for a combination of approaches to teacher development both as individuals and in groups. In particular, they raise issues of scale as a question of dissemination of the products of design studies and the need for developing capacity for teacher leadership to support dissemination of innovation. Scale-up research is only one phase of research described in the *Common Guidelines for Education Research* (USDOE & NSF, 2013) in which models are tested in natural settings with limited developer intervention. At this point, the professional development model is implemented by district or school-based facilitators; so documentation

about these roles is essential to provide evidence about the work at scale. Borko (2004) identified three phases of research about professional development which center on four elements which require investigation: teachers, facilitators, a professional development program, and context.

Phase 1 research activities focus on an individual professional development program at a single site. Researchers typically study the professional development program, teachers as learners, and the relationships between these two elements of the system. The facilitator and context remain unstudied. In phase 2, researchers study a single professional development program enacted by more than one facilitator at more than one site, exploring the relationships among facilitators, the professional development program, and teachers as learners. In phase 3, the research focus broadens to comparing multiple professional development implementations, each enacted at a collection of different sites. Throughout this model, researchers study the relationships among all four elements of a professional development system: facilitator, professional development program, teachers as learners, and context (Borko, 2004, p. 4).

The progression of a professional development program at a single site to later phases in which other facilitators lead implementation is challenging. As such, facilitator consideration is essential to both impact and fidelity. Consistent with commonly recognized “best practices,” many studies of teacher professional development include either school-based implementation or utilize small groups of teachers in ongoing work (Barlow, Burroughs, Harmon, Sutton, & Yopp, 2013; Borko et al., 2015; Slavit & Nelson, 2009). To effectively carry out these models, a facilitator or group organizer is required to support teachers’ learning. While there are multiple roles that a facilitator could play in these instances, the facilitator often influences the effectiveness and sustainability of the professional development despite their role. Exploratory or early-stage research may rely on an individual on the research team to facilitate the professional development. However, once the exploratory phase is complete, the facilitator is often removed and the teachers continue implementation in isolation. Without specific guidance or encouragement to continue the intervention, these initiatives can lose fidelity or be dropped altogether. As Cobb and Jackson (2015) suggest, building “others’ capacity” is essential. Carrying out studies of professional development that move beyond the researcher as leader of the teachers’ learning necessitates facilitators (Borko, 2004; Elliott et al., 2009). As a result, brokers, such as mathematics specialists, are required to bridge the relationship between researcher and practitioner, carry out the model that might be under investigation, or support implementation of new resources, models, or tools. This brokering process is particularly required when projects are scaled to multiple sites. Even in smaller projects, mathematics specialists might facilitate different groups of teachers. In school district positions, mathematics specialists can work for multiple schools. For researchers, this variation requires attending to the unit of analysis when designing researchable questions.

Mathematics Specialists as an Exemplar. “Armed with specific instructional and content expertise, [mathematics specialists] have the potential to conduct this heavy educative lifting to bring about instructional change.” (Woulfin & Rigby, 2017, p. 323). In research that centered on professional development models such as multi-tiered teaching experiments (Lesh, Kelly, & Yoon, 2008), models typically included three tiers: student, teacher, and researcher. Likewise, a common model in education research

is to consider the classroom, the school, and the district where students are nested in classrooms and teachers are nested in schools. We suggest an additional tier to these models to include the hidden players, in this instance, the mathematics specialist. For example, mathematics specialists often analyze teachers' work just as teachers analyze student work. This specific type of work requires researchers to engage in designing professional development for teachers in collaboration with the mathematics specialist. However, mathematics specialists require differentiated professional development experiences of their own as they facilitate teacher sessions (e.g. Lesseig et al., 2017). We describe the possible impacts of this tier on research design using qualitative and quantitative methods.

Woulfin and Rigby (2017) argue there is a need for qualitative research about mathematics specialists to better understand teacher interactions as they support instructional change. Case study research has been used to closely examine the daily work of mathematics specialists in schools (Chval et al., 2010; Mudzimiri, Burroughs, Luebeck, Sutton, & Yopp, 2014; Whitenack, Cavey, & Ellington, 2014). Instruments that mathematics specialists use to report their daily activities may be used as part of larger scale research (Campbell & Malkus, 2011). However, there is consensus that a mathematics specialist's role varies widely (deAraujo, Webel, & Reys, 2017; Mudzimiri et al., 2014; Woulfin & Rigby, 2017). Qualitative research presents an opportunity to study the variation across sites. For instance, a mathematics specialist's work with assessment data (Woulfin & Rigby, 2017) may vary across the school year depending on the implementation schedule of school- and district-level assessments. Given the challenges of self-reported data, the mathematics specialist also provides another perspective of the school setting, teacher practice, and teacher knowledge that may not be readily available to researchers. Since the mathematics specialist may regularly meet with teachers and possess insider knowledge of school and district initiatives, examining their role and influence provides critical insight.

Additionally, when documenting professional development in research, it is essential to identify the mathematics specialist within a group of teachers in professional development (e.g. a professional learning community, a lesson study team). In current research studies, analysis frequently neglects to report the presence or role of a mathematics specialist. Yet, no matter the professional learning structure, the mathematics specialists' disciplinary knowledge and positionality have the potential to influence other teachers within the group dynamic. Just as research reports identify teachers' experience, the role of the mathematics specialist as a "knowledgeable other" in any format of professional development is important to note when documenting interactions among participants. Similar to observing teachers in classrooms, observations and other data collection about mathematics specialist's work can provide information about how the professional development model functions at multiple levels.

Borko (2004) described the need to have multiple facilitators in large-scale studies. Yet, those facilitators present another level in quantitative analysis of data that should be considered by researchers to better understand underlying patterns in the data. While there are examples of instruments and protocols that have been designed as part of studies that included mathematics specialists (Barlow et al., 2013; Munter, 2014), there are still limited examples of instruments that are used to document mathematics specialist knowledge and expertise as distinct from mathematics teacher knowledge and expertise (Harbour, Livers, & Hjalmarson, 2019). A challenge for quantitative

research is the creation and implementation of measures for documenting the work of mathematics specialists (Harbour et al., 2019), as school districts are networks of schools which create nested data sets and complex models for analysis. In a hierarchical linear model, analysis might include student data as nested within teachers who are nested within schools. However, if mathematics specialists are present, analysis should consider the groups of teachers, within or across schools that are influenced. Just as students are nested within teachers, teachers are nested within mathematics specialists.

The work of mathematics specialists requires additional quantitative measures to understand and document their work with and influence on school stakeholders. If a particular professional development model was advocated, what was the fidelity of implementation of the model? What adaptations were made that could explain variation across research sites? Does the mathematics specialist have a view of the effectiveness of the model at supporting teacher learning? While additional measures may be necessary to document the regular work of mathematics specialists and their interactions with teachers (Campbell & Malkus, 2011; Munter, 2014), an ongoing challenge in instrument design is that the role, responsibilities, and title of the mathematics specialist vary widely across settings. Without consensus, the complexity of data collection and instrument validity increases.

In studies of diffusion or curriculum, the question of fidelity often arises (Clements, 2007; NRC, 2004). Drawing on Clements (2007) Curriculum Research Framework, the curriculum for teachers should be examined in terms of ideal, intended, designed, implemented, and assessed curriculum. This is critical for understanding whether and how curriculum was used to interpret results and measures of student learning across treatment and comparison groups. In such studies, no matter the methodology, teacher data needs to be gathered to understand curriculum usage. If we examine professional development curriculum or the implementation of a professional development model, a parallel principle holds with regard to mathematics specialists. As mathematics specialists use or advocate for particular models or resources, session data should be gathered to understand the use. This is especially important in describing results for comparison groups of teachers implementing different models, understanding variations on emerging models as implemented, and informing the cycles of revision that are characteristic of responsive professional development. Overall, data from mathematics specialists is needed to substantiate claims about teachers' learning experiences in K-12 settings.

Just as studies of curriculum implementation in classrooms should report on the training available for teachers (Clements, 2007; NRC, 2004), studies of professional development implementation should report on the training of leaders, or mathematics specialists. Are they experienced facilitators? Do they have formalized learning experiences or mathematics specialist certification? Have they received informal training? Do they have a defined role as a facilitator? Within research studies, the training of mathematics specialists should be explicit so researchers can better understand how the professional development model was implemented beyond the school and district levels (Borko, 2004; Koellner et al., 2011). Additionally, different stages of professional development research might call for different mathematics specialist selection. As a parallel, in curriculum research, an early-stage project might recruit more knowledgeable, experienced teachers to present ideal conditions. In professional development research, foundational stages might rely on experienced mathematics specialists who

maintain close proximity to the research team to ensure “ideal” implementation conditions. Research projects in later stages might have mathematics specialists less closely connected to the research team in order to understand implementation efficacy or effectiveness in a naturalistic manner (e.g. *Common Guidelines for Education Research* (U.S. Department of Education & National Science Foundation, 2013)).

Reconceptualizing Research Partners

“A design for supporting students’ learning developed and refined in the course of a classroom study is unlikely to contribute to improvements in classroom teaching and learning on a large scale unless researchers consider not merely their own but others’ capacity to support students’ and teachers’ learning from the outset of the study.” (Cobb & Jackson, 2015, p. 1035).

The mathematics education research community has been challenged to bring “research closer to teaching” (Cai et al., 2017, p. 514). To do so requires a reexamination of how we, as researchers, effectively implement research-based initiatives. In this article, we encapsulate this challenge via a mathematics specialist who is positioned as an intermediary between the research team and teachers. Mathematics specialists are likely primary implementers of resources and models so it is logical to include them in research and design implementation as they can maintain consistencies within sites, for instance, the mathematics specialist be the facilitator for a lesson study implementation in a school. While some schools have existing structures for instructional leaders who have received specific professional development on supporting teacher learning and development, like mathematics specialists (Campbell & Malkus, 2011; Chval et al., 2010), at other schools, the research team must identify leaders to support professional development implementation (e.g. Cobb & Jackson, 2011, 2015). As a research team member, the mathematics specialist can serve as a bridge connecting research to practice, particularly if they possess existing professional relationships. The mathematics specialist can support recruitment of participants who meet certain criteria and present as someone familiar to build trust between teachers and researchers. Beyond recruitment, the mathematics specialist’s knowledge of local context can prove instrumental in identifying potential pitfalls of new initiatives or potentially competing initiatives. Specifically, the way in which a mathematics specialist identifies connections between the professional development, the school stakeholders’ needs, and the district goals can support the overall synthesis of situational knowledge which ultimately increases the effectiveness of research-based professional development initiatives within school settings. In order to make questions about the effectiveness and impact of professional development researchable, mathematics specialists should be engaged as partners in the research. As Jackson et al. (2015) point out for capacity building, mathematics teacher leaders can also play a role in data collection and analysis (e.g. collecting artifacts from teachers, providing field notes about interventions). In addition, mathematics specialists’ perspective as an on-the-ground users of professional development models can support revisions over time and understanding how models work in different settings.

Due to their disciplinary and instructional expertise and their ability to engage in local school- or district-based professional development settings, mathematics specialists are situated to act as agents of change. Mathematics specialists serve as providers of professional development, resources, and expertise while also considering how and when to share this expertise to achieve goals centered on instructional shifts. Each interaction requires differentiated support for teacher development and a specialized leadership knowledge that distinguishes the specific knowledge required for supporting teachers from the content and pedagogical knowledge required for teaching students (Bitto, 2015). It is also essential to be explicit about describing the mathematics specialist and their credentials just as studies report on the experience and background of classroom teachers. Due to their specialized knowledge and positioning, Woulfin and Rigby (2017) describe the mathematics specialist as a potential broker between administration and teachers as a significant component of instructional reform. We also posit that the mathematics specialists can broker research and practice due to their unique positioning in the local context and their ability to support responsive professional development for the teachers involved.

Research on effective professional development highlights the importance of collaborative and collegial learning environments and communities of practices in schools (Darling-Hammond & McLaughlin, 1995; Franke & Kazemi, 2001; Knapp, 2003). While there is a tradition in mathematics education of engaging the teacher as researcher (e.g. Doerr & Tinto, 2000) and exploring the teacher's role as part of the research (Simon & Tzur, 1999; Steffe & Thompson, 2000), what is less clear in research are the roles of mathematics specialists in design and implementation. Professional development models and methodologies such as design-based implementation research (e.g. Cobb, Jackson, & Dunlap Sharpe, 2017; Penuel et al., 2011) engage school and community stakeholders as critical members of the research team. As essential research participants, these members provide perspective on local context and inform the design of the professional development model as it unfolds. Like McGatha, Davis, and Stokes (2015), when reviewing research, we found that despite indications of the presence of a mathematics teacher leader, possibly a mathematics specialist, the reporting of specific contributions was limited. Within the tradition of teacher as researcher in mathematics education research, we suggest there is also a space of mathematics specialist as researcher in which research examines their practice or influence. In our own work with mathematics specialists' professional development, we have used self-study research models (Baker, Bitto, Wills, Galanti, & Eatmon, 2018) to support teacher leaders in developing their practice as leaders of other teachers. However, action research and teaching experiment models could provide other venues of capturing this essential work. Since there are limited examples of mathematics specialist self-reports either formally (Knapp, 2017) or informally (Felux & Snowdy, 2006), we suggest this is an area of future research and inquiry where mathematics specialists engage as members of both the research team and research of their practice.

Implications for Research and Researchable Questions

To describe possible research questions, we discuss ways in which the mathematics education community can reimagine and reconceptualize the design, implementation,

and reporting on professional development research. To illuminate both the complexity of this work and the intricate relationships hidden players can have with other school stakeholders, we examined one hidden player, the mathematics specialist. As mentioned previously, we recognize there are many other hidden players across not just mathematics, but other disciplines as well. We suggest a few implications for researchable questions and the resulting research design that will add value to research about professional development. Broadly, the outcome of the research about mathematics teaching should be to generate understanding of teachers' development, systemic change, and mathematics teaching that is shareable across settings. In describing research that includes any professional development facilitators, researchers should respond to the following.

Creating Operational Definitions and Identifying Hidden Players

The first set of questions are about clearly identifying the characteristics of the professional development model and the individuals who are directly working with the teachers.

- What are the details of the specific treatment or intervention (e.g. lesson study, coaching) that was used?
- Who supports the classroom teacher with planning and instruction?
- What formal or informal role(s) do these individuals play in schools or districts?
- What is their background or professional experiences?
- What are their types of interactions with other school stakeholders?
- What influence does their positionality afford (or constrain) them?

Identifying the Unit of Analysis & Scaling up Professional Development

The second set of questions is about the structure and design of the professional development in terms of how it was organized and how evidence was gathered for research.

- What is the unit of analysis (e.g. schools, classrooms, groups of teachers, individual teachers, districts)?
- Are there measures of fidelity of implementation?
- Is there school- or district-based data from the school-based facilitator's perspective about their work?
- Is there data from the perspective of the school-based facilitator about the research-based implementation experience?
- What is the ratio of teachers to teacher leaders/facilitators?
- Who within the professional development context is situated to serve as on-the-ground support (school-based facilitator)?
- What is the nature of the school-based facilitator's work with teachers?

- What roles do the facilitators have in shaping issues of equity and diversity in classrooms, schools, and communities?
- How does the school-based facilitator's interactions influence decision-making within the context of the study (e.g. district, school, team)?
- What professional development or training is included for the school-based facilitator?
- What knowledge or background did the school-based facilitator have prior to the training?
- What was the duration of the school-based facilitator's training?
- In what ways is the school-based facilitator's learning related to the specific contexts within which their teacher leadership is enacted?

In developing questions, researchers should consider terminology they use to describe specialists' work (e.g. referring back to McGatha and Rigelman's framework (2017)). To make those questions researchable, investigators need to determine how the constructs can be operationalized in the study and how evidence can be gathered to serve the questions. Up to this point, there has been limited reporting in studies about the work of professional development facilitators (e.g. mathematics specialists). For professional development to become researchable (especially at scale), more documentation is needed about the role of such facilitators. In this case, "researchable" indicates that the investigation would provide evidence of effectiveness that can then be used in other settings. As a parallel, researchers have long included information about the teacher when reporting on studies of curriculum or other classroom interventions. We argue that as understanding the teacher is critical to understanding students, the facilitator is critical to understanding teacher professional development. For instance, mathematics specialists should be included in plans for data collection about the intervention in order to support understanding fidelity of implementation of the professional development model. Interviews with mathematics specialists can provide information about how to design and refine the experience for teachers. Questions about how to design professional development can become researchable if researchers engage mathematics specialists' knowledge and expertise to gather evidence.

In this paper, we argued broadly for the need to examine and include possible hidden players in professional development. For instance, research should include mathematics specialists in research and design of teacher professional development. As research and design efforts are scaled up, mathematics specialists and other school-based individuals may play essential roles. As a result, the mathematics education research community needs to incorporate mathematics specialists as partners in both research and design. From a qualitative perspective, mathematics specialists contribute to the depth of understanding of the phenomenon under investigation and may possess "insider" knowledge not available to the researcher otherwise. From a quantitative perspective, the role of the mathematics specialist should be included as a level in the statistical analysis and to document variation that may occur. To understand the professional development design, the mathematics specialist plays an analogous role to the teacher in a study of curriculum since they may be a primary user. Underlying each of these methods is the need for investigations of the mathematics knowledge for leadership that mathematics specialists possess. Similar to mathematics teaching, mathematics

leadership is not independent of content, culture, or context. In short, it is time to position mathematics specialists as critical players in the research and professional development of mathematics teachers.

For researchable questions about professional development, the questions and considerations we have raised about mathematics specialists apply also to other roles in schools (e.g. literacy specialists, technology specialists) who may play a role in professional development. Questions about professional development effectiveness need to go beyond data collection about students and teachers to other individuals involved in the intervention. In creating operational definitions, researchers also need to be clear about the kind of teaching and professional development practice they are supporting. So, the school context needs to be clearly explained and defined beyond the demographics in order to understand how the professional learning fit within other initiatives. We have not extensively discussed these initiatives in terms of equity and social justice, but we view greater clarity about roles as also applicable to other positions in schools that might influence mathematics teaching and learning for students who have been historically underserved (e.g. special education teachers, supports for multilingual students).

For researchable questions in mathematics education, professional development investigations present opportunities and challenges for research. There are opportunities to better capitalize on existing but hidden resources (e.g. mathematics specialists) that can support the intervention itself and the research about that intervention. Better research about such hidden resources might also increase access to such resources for more schools. Ultimately, our hope is for research about professional development in mathematics teaching and learning that can then inform subsequent research in new contexts. As our primary goal is to advance students' learning of mathematics, we view professional development for teachers as essential to that goal.

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