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Los Angeles

Stories from Mathematics Specialists:

Transitioning from Classroom to Coach

A dissertation submitted in partial satisfaction of the

requirement for the degree Doctor of Education

by

Christin Ahn

2019

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2019

ABSTRACT OF THE DISSERTATION

Stories from Mathematics Specialists: Transitioning from Classroom to Coach

by

Christin Ahn

Doctor of Education

University of California, Los Angeles, 2019

Professor Megan Franke, Co-Chair

Professor Diane Durkin, Co-Chair

Elementary schools are increasingly hiring mathematics specialists to work as on-site experts to assist educators with the changes in mathematics standards, curriculum, and expectations for teaching practices. These mathematics specialists usually enter into their positions without formal training and find themselves as novices in their roles. The purpose of this study was to understand the experience of transitioning into mathematics specialist roles in independent elementary schools across Southern California. This study included interviews with 16 math specialists to gather their stories of transition and learning. The major finding of this study indicated that the ability to build relationships was a necessary skill for math specialists as they continued to build their pedagogical and content knowledge and managed both the successes and challenges of their new roles.

The dissertation of Christin Ahn is approved.

Kimberley Gomez

James Stigler

Megan Franke, Committee Co-Chair

Diane Durkin, Committee Co-Chair

University of California, Los Angeles

2019

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VITA

2009	B.A. in Economics Benedictine University Lisle, Illinois
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2012-2014	Mathematics and Science Teacher Brentano Math & Science Academy Chicago, Illinois
2014-2015	Mathematics Teacher Percy Julian Middle School Oak Park, Illinois
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Chapter 1: Statement of the Problem

Project Synopsis

Through this study, I intended to collect the stories of individuals who have transitioned from holding teaching positions to working as math specialists in independent elementary schools throughout the Los Angeles and Southern California region. By listening to their stories, I hoped to learn the skills specialists had to gain in terms of their mathematics content knowledge, pedagogical knowledge, and collaborative-leadership skills, as well as the factors that may have helped or hindered these specialists' growth.

National Problem of Student Performance in Mathematics

The landscape of mathematics education in America has been changing, with large-scale reforms like the Common Core aimed at improving instruction as well as student performance. Overall, elementary school students in the United States are falling behind in their mathematics performance in comparison to their international counterparts. Out of the 34 countries in the Organization for Economic Co-operation and Development (OECD), the United States falls below average and was ranked 27th in 2012 (Programme for International Student Assessment, 2012). Only 2% of students in the United States can perform at the highest level of the Programme for International Student Assessment (PISA) compared to an average of 31% in Shanghai-China. In 2013, only 41% of fourth grade students were deemed proficient in math as measured by the National Assessment of Educational Progress (Jayanthi, Gersten, Taylor, Smolkowski, & Dimino, 2017). This underperformance in mathematics continues to be a problem as

children become adult students who also struggle in math, with almost 66% of 2-year college students being placed in remedial courses for mathematics (Taton, 2015).

The current mathematics standards state that a student should be able to demonstrate an understanding of content through practices that require higher-order thinking skills. In order to support students with these new standards for mathematics content and practices, teachers need to continually develop new knowledge and skill sets in mathematics pedagogy. Research suggests that elementary math teachers who understand and can support student thinking can create environments that support student learning (Franke, Carpenter, Levi, & Fennema, 2001). However, changing longstanding teaching practices is challenging and requires ongoing learning and support (Battey & Franke, 2008).

Characteristics of an Effective Mathematics Teacher

New mathematical standards. The content and practice standards outlined in the Common Core Standards require that students are able to problem-solve, create different representations and diagrams of math problems, think creatively and critically, and collaborate and analyze (Doyle, Huie Hofsetter, Kendig, & Strick, 2014). In order to develop these understandings, teachers themselves need to know to solve non-traditional problems that involve more than rote memory or repetitive, procedural skills. Additionally, teachers need to be able to analyze students' mathematical thinking and design as well as modify instruction (Kazemi & Franke, 2004). For example, higher order thinking skills encouraged by the Common Core Standards includes tasks requiring students to analyze mathematics problems as well as demonstrate understanding using multiple ways of solving a particular problem. Supporting this type of thinking requires

teachers to have particular knowledge, skills, and understandings (Hill et al., 2008). These reforms require that teachers be continual learners (Franke et al., 2001).

Content knowledge and pedagogical knowledge. An effective mathematics teacher needs both content knowledge and pedagogical knowledge to support instruction (Ball, 2005; Hoover, Mosvold, Ball, & Lai, 2016; Walker, 2007). Through assessments and observations of elementary school teachers, several studies have shown that teachers lack adequate knowledge and proficiency of mathematics content (Barrett, Cowen, Toma, & Troske, 2015; Hill et al., 2008; Timmerman, 2014; Walker, 2007). In these situations, a teacher can teach his/her students incorrectly; moreover, it is almost impossible to remediate this lack of content knowledge with pedagogical skills (Hill et al., 2008). Furthermore, teachers need to know how to adequately assess students' prior knowledge of students, set proper instructional goals, lesson plan, carry out multiple instructional strategies, demonstrate and explain concepts, assess student understanding, and meet the various needs of students, including those with learning difficulties (Ozdemir, Sahin, Basibuyuk, Erdem, & Soylu, 2017). Doing so requires pedagogical knowledge (Hill et al., 2008; Walker, 2007).

As standards change, schools will adopt new mathematics curriculum and instructional resources to align with the standards (Hopkins, Spillane, Jakopovic, & Heaton, 2013). As this happens, teachers need continual support in developing both their content knowledge and pedagogical knowledge.

Math Coaches/Specialists

In order to address the recent accountability measures such as No Child Left Behind (NCLB) and the Common Core Standards, schools have increasingly started to

hire mathematics coaches/specialists (Ellington, Whitenack, & Trinter, 2017; Sailors & Shanklin, 2012; Walkowiak, 2016). These coaches are able to support teachers with mathematics instruction through designing professional development sessions, gaining access to classrooms, understanding the issues affecting teachers and classrooms, and serving as a continual support; this model can be more effective than large scale professional development programs in addressing the individual needs of classroom teachers (Hartman, 2013; Mudzimiri, Burroughs, Luebeck, Sutton, & Yopp, 2014). Moreover, the National Council of Teachers of Mathematics (NCTM) and the Association of Mathematics Teacher Educators (AMTE) are advancing efforts to encourage mathematics instructional leadership positions at the elementary school level (Ellington et al., 2017).

In independent elementary schools, administrators can decide to raise funds and hire mathematics specialists to support teachers and their mathematics department. Although the intended goals and position of mathematics specialists in independent settings can vary significantly, they hold roles that are distinctly different from the regular classroom teachers they work with (Ellington et al., 2017). Campbell and Malkus (2011) stated that there is no single model of coaching, and these personnel may be professionally titled "specialist, coach, support teacher, or support leader" (p. 432); however, the intention is to hire a knowledgeable educator who specializes in mathematics education to take on the role of instructional coach in order to advance instructional practices including content, pedagogy, and curriculum use (Campbell & Malkus, 2011; Walkowiak, 2016).

In the independent school setting, these professionals are usually referred to as *mathematics specialists*. Although their day-to-day activities may vary, the primary goals of math specialists are to be a source of support for other math teachers with mathematics content knowledge, pedagogy, and curriculum; design and lead professional development; and instruct students.

Limited research. Since hiring a mathematics specialist has only gained popularity recently, there is a lack of extensive research into those in these positions. However, there is research that examines the role of instructional literacy coaches as these positions are more prevalent than mathematics coaches (Ellington et al., 2017; Killion, 2017; Walkowiak, 2016). According to Campbell and Malkus (2011), a small body of research addresses the influence of mathematics coaches by examining teachers' perceptions of their own instructional changes, and a few studies have examined challenges coaches face in their positions. Furthermore, existing research does show that math specialists must learn how to collaborate with colleagues while developing their own professional identities (Mudzimiri et al., 2014).

There is even less research examining mathematics specialists working in independent schools, a focus that is important because of the autonomous nature of independent schools: a lack of state regulations makes them uniquely different from public schools and from each other. Overall, the position of mathematics coach is a demanding position, one that is just beginning to be examined and understood (Campbell & Malkus, 2011).

Difficulties of Transitioning into a Coaching Role

Successful mathematics teachers are typically chosen for positions of math specialists, under the assumption that effective teachers can be effective coaches (Chval et al., 2010; Fennell, Kobett, & Wray, 2013). However, when teachers enter these positions, they become novices again and need to deal with new challenges of the profession (Campbell & Malkus, 2011; Fennell et al., 2013).

Although certain states have recommended pathways for formal training, many math coaches enter into this role without formalized training (Ellington et al., 2017; Reys & Fennell, 2003; Swars, Smith, Smith, Carothers, & Myers, 2018). Subsequently, when teachers assume a coaching position, they need to navigate a new position in a complicated social system that includes themselves, others, the institution, and cultural factors, in addition to established policies (Smith, Hayes, & Lyons, 2017). In order to be successful, math specialists need to learn how to develop trusting relationships with their colleagues, lead professional development sessions to teach adults, use and evaluate resources, and provide instructional leadership to improve their mathematics programs (Fennell et al., 2013; Zuspan, 2013).

The Study

I conducted this qualitative study to investigate mathematics specialists in elementary independent schools in California and how they transition from full-time teaching positions. I aimed to collect their stories of the ways in which they came to understand pedagogy, pedagogical content knowledge, and leadership and relationship skills affecting their ability to do their jobs.

This study addressed a gap in research regarding mathematics specialists in independent elementary school settings. I focused on independent schools because they provide a unique setting in that they operate autonomously with regard to funding, choosing curriculum, and hiring decisions. Since independent schools are able to make decisions regarding hiring without having to adhere to state regulations, this may attract educators with professional experiences that are different from specialists working in public schools. Additionally, independent schools attract a unique group of students as well as parents with specific expectations of the school and mathematics program. Thus, the autonomous nature of schools and expectations can create variances in the role and objectives of a mathematics specialist. Examining these variances and being aware of them can better prepare those entering into these positions. Furthermore, most elementary schools do not have mathematics specialists, and schools that do hire them are unique, making it worthwhile to examine the reason for hiring specialists and what their roles are.

I strove to answer the following research questions:

1. According to the mathematics specialists, what did they have to learn in terms of content knowledge, pedagogical skills, and relationship-building and leadership skills?
2. According to the mathematics specialists, what were the challenges and support systems present at their school sites?
3. According to the math specialists, what was their initial intended purpose for their roles, and how has this changed, if at all?

Examining coaching in mathematics can contribute to improving mathematics education. I hope this research will provide insight for math specialists who seek to improve their practice to best serve their students.

Chapter 2: Literature Review

In order to address the relatively poor mathematics performance outcomes of students in the United States, we need to examine and improve teachers' instructional practices. Student performance is inevitably tied to teacher instruction, so improving teaching practices would affect student outcomes (Lachner & Nückles, 2015). With the recent changes in standards and accountability measures, school systems must figure out how to create new conditions for instructional improvement, including providing professional development, adopting a new curriculum or teacher evaluation system, and/or providing coaching. Changes in school infrastructure to support mathematics teachers is essential because teachers need to be continual learners throughout their careers in order to meet the challenges of changes in content standards, curriculum, and even methodologies and mindsets regarding teaching and pedagogy (Hopkins, Ozimek, & Sweet, 2013). The most common short-term and large-scale professional development models have shown to be ineffective and irrelevant to teachers.

To address math teachers' needs, elementary schools and school districts are increasingly hiring mathematics specialists to work with their teachers and students; furthermore, research has shown that mathematics specialists and designated instructional coaches who work at school sites have a greater impact on improving teaching practices than large-scale professional development sessions (Hopkins et al., 2013). Mathematics specialists are also called *mathematics coaches*, and throughout my research, I use the two job titles interchangeably. Although their titles and roles may vary, these specialists are seen as experts in mathematics content, pedagogy, and curriculum in their schools, and their input affects school-wide decision-making regarding how mathematics is taught

within their schools. Overall, these instructional experts support teachers with mathematics content, pedagogy, and even mindsets toward teaching mathematics. Most independent elementary schools throughout Los Angeles refer to these employees as mathematics specialists, which is the term I use most frequently.

However, despite their essential roles with their assigned teachers and classrooms, many mathematics specialists lack training and enter their roles without any specific content or leadership training beyond what any mathematics teacher has had. Mathematics specialists need to learn content spanning various grade levels that they may not have taught before; plus, they must gain new leadership skills in order to build trust and rapport with their colleagues.

Beyond needed content and leadership skills, little research has explored how mathematics specialists transition into instructional leadership roles and what skills they need to learn along the way. Examining the transition process from teaching to coaching can inform teachers entering into coaching roles as well as those making hiring decisions. Therefore, I begin with an examination of the components that make up effective mathematics instruction and explore the reasons why large-scale professional development is ineffective. Additionally, I discuss the research behind the effectiveness of mathematics specialists as well as the lack of training provided to those who transition into these roles.

Components of Effective Mathematics Instruction

Usually, those hired as mathematics specialists have demonstrated a strong aptitude as mathematics educators. When they take on their roles as a mathematics specialist, they often need to understand effective teaching practices of grade levels they

may not have taught before in order to assist teachers and students effectively. Thus, it is imperative for a mathematics specialist to understand the necessary components of effective mathematics instruction.

Historically, what scholars have emphasized as important in mathematics education has vacillated between focusing on teachers' content knowledge and focusing on pedagogical knowledge (Hoover et al., 2016). Typically, teachers are only formally assessed on their content knowledge when they are qualifying to become credentialed teachers; however, teachers are evaluated solely on their pedagogical skills throughout their careers (Shulman, 1986; Walker, 2007).

Content knowledge. Educators need to continue to develop their understanding of mathematics and need to comprehend mathematical content that is more rigorous than what they present to their students (Taton, 2015). Moreover, in order to teach the higher-order thinking and problem-solving skills outlined in the Common Core Standards, teachers need to possess this knowledge themselves (Doyle et al., 2014; Hill et al., 2008).

Researchers Hill et al. (2008) analyzed the relationships between a teacher's mathematical knowledge for teaching, including formal mathematical content knowledge (basic mathematics used and understood by those outside of the education field) and pedagogical content knowledge (PCK; mathematical knowledge specific to education professionals). They found that overall "stronger teacher knowledge yields benefits for classroom instruction and student achievement" (p. 431). Specifically, they found "a powerful relationship between what a teacher knows, how she knows it, and what she can do in the context of instruction" (p. 497). Teachers' understanding of mathematics content knowledge corresponds with an improved quality of instruction; moreover,

content knowledge is a fundamental and necessary requirement of effective mathematics teaching.

Through assessing and observing elementary school teachers, several studies have shown that elementary teachers lack adequate knowledge and proficiency of mathematics content (Barrett et al., 2015; Hill et al., 2008; Timmerman, 2014; Walker, 2007). In these situations, a teacher can inform his/her students incorrectly, and it is almost impossible to remediate this lack of content knowledge with pedagogical skills (Hill et al., 2008). In fact, a study by Lachner and Nückles (2015) demonstrated that teachers with a strong mathematical content knowledge and a relative lack of pedagogical knowledge can bring about stronger student outcomes in comparison to teachers with strong pedagogical knowledge and a relative lack of content knowledge.

Hill et al. (2008) conducted a study where teachers were assessed to determine basic content knowledge and mathematical knowledge (i.e., solving a problem in multiple different ways—things a teacher needs to think about in the moment while teaching) and even students' knowledge. Lessons were videotaped, teachers were interviewed and surveyed (to assess mindset), and teaching was observed. Data was quantified and scored and videos and test scores were compared for correlation. The authors found a strong correlation between mathematical knowledge and quality of instruction; "stronger teacher knowledge yields benefits for classroom instruction and student achievement" (p. 431). Overall, teachers' mathematics content knowledge corresponded with an improved quality of instruction, which is one of the fundamental components of effective mathematics teaching. Interestingly, they found other factors that may prevent teachers with high mathematical knowledge from delivering high quality instruction (including

lacking in making connections/clarifying purpose of lesson, improper use of supplements, wasting time) and how teachers with low mathematical knowledge could remediate their lack of knowledge (not wasting classroom time, teacher seeking out professional development, and following the textbook). The authors went on to recommend hiring teachers who only teach elementary math.

Similarly, to remediate the possible lack of teachers' mathematics content knowledge, countries such as South Korea and Sweden require content-specific preparation and teaching positions for their elementary school teachers, meaning elementary teachers are trained to teach a specific content similar to secondary teachers. Although most states in the United States require six to nine college credit hours for pre-service elementary teachers, the college-level mathematics courses required are irrelevant with regard to the content knowledge necessary for teaching elementary mathematics. Additionally, elementary teachers often need to teach several different content areas (such as social studies, reading, science, etc.) and it is unrealistic to assume that elementary teachers have specialized knowledge in teaching mathematics content (Reys & Fennell, 2003).

Pedagogical knowledge. Although content knowledge of mathematics is essential for effective teaching, by itself, it is not enough. Teachers need to possess both content knowledge as well as pedagogical knowledge in order to engage students and support their students' mathematical learning (Ball, 2005; Hill et al., 2008; Hoover et al., 2016; Shulman, 1986; Walker, 2007).

According to Shulman (1987), effective teachers need to possess PCK just as they need content knowledge itself. PCK is knowledge of how to teach the content, including

knowledge of student thinking, being able to analyze a task in relation to student thinking and mathematics, being able to choose numbers in a problem that will support the desired mathematical thinking, etc. In this manner, elementary mathematics teachers need to adequately assess students' prior knowledge, set proper instructional goals, lesson plan, carry out multiple instructional strategies, demonstrate and explain concepts, assess student understanding, and meet the various needs of students with different learning styles and learning difficulties (Ozdemir et al., 2017). Specifically, teachers need to be able to listen to students as well as analyze their work to understand student thinking, which will affect the instruction that the teacher provides. In this manner, a teacher will be attentive to his/her students, be receptive to and gauge student understanding, and incorporate students' thinking into shaping the lesson moving forward . In essence, the teacher is learning from his/her students, adapting moment-to-moment to meet their needs (Franke & Carpenter, 2001; Gibbons, Kazemi, & Lewis, 2017).

Professional Development Sessions

Many professional development opportunities available for teachers are offered in the form of large-scale, single-session workshops; these are the most common types of professional development attended by teachers (Darling-Hammond & Richardson, 2009). Most educators are required to attend professional development for continued learning by their schools or through state mandates for retaining their teaching credential (Barrett et al., 2015).

However, many are not useful in creating long-term changes in instruction because these short-term and large-scale programs, which are the most common forms of professional development attended by teachers, are not consistently effective. This is

partly because teachers typically receive less than 16 hours of content-specific training annually (Darling-Hammond & Richardson, 2009). Most professional development programs are focused on teachers' fidelity to a specific program (Franke et al., 2001).

For example, Jayanthi et al. (2017) conducted a study of Developing Mathematical Ideas (DMI), a program intended to improve understanding of fractions for fourth grade teachers and subsequently their students throughout eight school districts across the states of Florida, Georgia, and South Carolina (70 urban and 14 rural) during the 2014-2015 school year. Following the implementation of DMI, results demonstrated no significant increase in students' understanding as demonstrated on state math exams. Results also showed that teachers who participated performed slightly better than the control group. Eighty-four percent of teachers in seven districts agreed or strongly agreed that DMI improved their knowledge of fractions; however, one district provided negative feedback. Researchers surmised that a more differentiated professional development program and coaching support for teachers focusing on fewer concepts could have been more beneficial.

This type of training is unrelated to the day-to-day instructional activities of teachers and what is going on in their classrooms. As teachers try to implement their learning in their own classrooms, they are unable to follow the recommended procedures and protocols because they need to adapt to their students' needs (Boonen, Reed, Schoonenboom, & Jolles, 2016; Taton, 2015). This is because large-scale professional development often fails to address teachers' specific needs as well as their classes (Boonen et al., 2016). These professional development sessions do not result in significant, long-term student gains because they are not structured to continually support

the teachers throughout the year, nor do they focus on the individual needs of students in the classroom (Taton, 2015). For these reasons, the goals of a professional development program typically fall short of its intention.

Additionally, teacher and student outcomes are not examined within many professional development programs, meaning there is no assessment process to determine effectiveness. As a result, school districts adopt such programs without proof of their educational impact. Only a few studies have followed teachers for over a year after the programs to examine sustainability and generativity (Franke et al., 2001). Research has shown that professional development may even have negative effects due to problems with implementation and lack of support (Barrett et al., 2015; Garret et al., 2016; Gersten, Taylor, Keys, Rolfhus, & Newman-Gonchar, 2014; Jayanthi et al., 2017). Overall, accountability needs to improve to ensure that teachers' time as well as monetary resources are not being wasted (Barrett et al., 2015; Hill, 2008). For instance, certain professional development programs have demonstrated an insignificant or even a negative impact on student performance (Barrett et al., 2015; Hill, 2008, Jayanthi et al., 2017; Garet et al., 2016; Gersten et al., 2014). These results occur because large-scale program are not tailored to meet the needs of the schools and classrooms they are serving. Moreover, the content taught in these sessions can be inconsistent with programs and curriculum being implemented by schools; subsequently, professional development can cause more difficulties in teaching (Hill, 2008).

Furthermore, schools and school districts spend a significant amount of money on professional development for their teaching staff, between 1-6% of their expenditures, and teachers often pay for their own professional development (Hill, 2008). Research has

shown that even trainers leading professional development sessions can be unqualified and lack knowledge in comparison to the teachers they are teaching (Hill, 2008; Lachner & Nückles, 2015). This is because it is difficult to ensure that professional development leaders are knowledgeable and a good fit for the teachers they are serving (Lachner & Nückles, 2015). Consequently, professional development of teachers is a large business and one that is not regulated.

Professional development in general has been found to be limited in helping teachers improve their teaching (Darling-Hammond & Richardson, 2009). This is particularly true with regard to the discipline of mathematics. Focused on the problem of providing appropriate instructional support, research indicates that having a mathematics coach is more effective than large scale professional development programs in addressing the individual needs of classroom teachers (Sailors & Shanklin, 2012). However, the shortcomings of the most common forms of professional development may point to ways in which professional development as well as teacher-support and training approaches can be improved.

Long term support. Although most research shows that large scale professional development sessions are less effective, lessons that can be learned from examining these programs. Certain professional development programs have been shown to yield long-term, positive impacts. Long-term programs that focus on increasing a teacher's skill, such as listening and gauging student thinking, rather than following a specific program or curriculum and mentorship over several years can improve teaching practices (Franke et al., 2001). Furthermore, programs that address both content and pedagogical

knowledge have produced at least short-term changes in teaching (Boonen et al., 2016; Timmerman, 2014).

Specifically, Franke and her colleagues (2001) showed that long-term professional development focusing on having teachers develop instructional materials spanning several years with opportunities for teachers to collaborate continually even after the professional development can lead to change and reform. This particular program did not require fidelity to instructional materials provided to teachers; rather, it was adapted to meet the needs of teachers with their students in mind. When teachers were given descriptions of instructional practices at a single professional development session, fewer teachers used the skill in their classroom than when coaching was added as a staff development tool (Zuspan, 2013).

Finally, hiring mathematics coaches at a school site may be more impactful than the aforementioned short-term professional development sessions. However, the importance of components and outgrowths of professional development is that most mathematics specialists lead professional development sessions in their school(s) and may be limited to several sessions per year (Ellington et al., 2017; Gibbons et al., 2017, Hopkins et al., 2013). Thus, specialists need to learn how to most run professional development effectively.

Definition of Mathematics Specialist

Hiring coaches was first mentioned by Joyce and Showers in the 1980s as an outgrowth of professional development (Chval et al., 2010). Coaching started in the early 1980s due to new and tougher standards for students' learning outcomes (Chval et al., 2010; Neumerski, 2012). The lack of research regarding mathematics specialists is

because this position has gained popularity more recently as a result of increasing accountability regulations and standards (Walkowiak, 2016). Elementary school mathematics coaches focus on working with individual teachers to foster instructional change, and they are also expected to advance a school's mathematics program (Campbell & Malkus, 2013).

Also, accountability measures such as NCLB and the increasing importance of having qualified teachers have served as compelling reasons to provide coaching to teachers (Ellington et al., 2017; Hopkins et al., 2013; Lachner & Nückles, 2015; Sailors & Shanklin, 2012). Moreover, the adoption of the Common Core Standards has necessitated training for teachers to ensure that students are able to meet the higher, more demanding cognitive expectations. These changes have increased the number of mathematics coaches hired within schools (Campbell & Griffin, 2016; Walkowiak, 2016). Also, organizations like NCTM and AMTE have been working to encourage the development of these instructional leadership positions on a national scale (Ellington et al., 2017).

Overall, there is no single model or definition of mathematics coaching, and those serving in these roles may officially be titled "specialist, coach, support teacher, or support leader" (Campbell & Malkus, 2011, p. 432). Although the official titles may differ, the intention is to have a knowledgeable educator in the building who specializes in mathematics education to provide instructional coaching and advance instructional practices including content, pedagogy, and curriculum (Campbell & Malkus, 2011; Ellington et al., 2017; Walkowiak, 2016). Furthermore, they may need to take the lead in creating whole-school educational reform (Gibbons et al., 2017; Neumerski, 2012).

Although there is no broadly accepted, formal definition of a mathematics specialist, some organizations have begun to clarify the professional obligations of this role. The 2012 NCTM/NCATE standards for elementary mathematics specialists include demonstrating instructional leadership through coaching and mentoring by

> building and navigating relationships with teachers, administrators, and the community; establishing and maintaining learning communities; [and] analyzing and evaluating educational structures and policies that affect students' equitable access to high quality mathematics instruction. (Fennell et al., 2013, p. 178)

Effectiveness of Math Coaches

Coaches are able to gain access to classrooms and understand the issues affecting individual teachers and classrooms; the coaching model can be more effective than large scale professional development programs in addressing the specific needs of classroom teachers (Hartman, 2013; Mudzimiri et al., 2014). Researchers Campbell and Malkus (2011) randomly assigned mathematics coaches to schools across Virginia to test whether their presence would affect student scores on standardized exams. They found that although the scores did not increase significantly during the first year the coaches were assigned, student performance scores did improve during the second and third year. The researchers also looked into how these coaches spent their days and found that the longer a coach worked at a site, the greater time he/she spent communicating with other staff. This time was spent discussing mathematics education as well as building personal relationships, both of which are important aspects of the coaching role. This study demonstrated that having a coach could positively impact teachers' instructional practices and student outcomes. Similarly, a meta-analysis conducted by Kraft, Blazar, and Hogan

(2018) demonstrated that coaching is effective in yielding positive student outcomes in several content areas, including mathematics.

From Teacher to Specialist

Often, successful mathematics teachers are chosen for positions of instructional leadership. However, when teachers become mathematics specialists, they become novices all over again and are met with new challenges of being mathematics instructional leaders (Chval et al., 2010).

Frequently, the role of a math coach is not defined specifically when one is hired, and some principals do not know what a coach needs to do at their school site. In this manner, mathematics coaches take on ambiguous responsibilities and are accountable for inventing their own roles without much guidance (Sailors & Shanklin, 2012). Throughout the years, even though the role is not specifically defined when one is hired, a math specialist's role may change and his/her obligations and goals may become clearer over time (Sailors & Shanklin, 2012; Walkowiak, 2016; Zuspan, 2013). Furthermore, the goals of instructional outcomes are different for each school; this needs to be clarified as specialists assist teachers (Neumerski, 2012).

Walkowiak (2016) identified five needs for a math coach: to have a clearly defined role, to establish trust with teachers, to value teachers' ideas and work collaboratively, to set clear goals for teachers, and to hold conversations with teachers regarding student outcomes. Although lot is expected of mathematics coaches in terms of academic leadership, many enter into this role without guidance.

Training for Math Specialists

When teachers transition into new coaching roles, they usually do not receive any formal professional training. One study conducted by Campbell and Malkus (2014) demonstrated the effectiveness of preparing future mathematics specialists by providing an extensive learning opportunity for developing mathematical content knowledge and leadership training . Throughout this particular training, these specialists-in-training improved in their mathematical understanding and even changed their beliefs about teaching (from a more traditional sense to a belief in exploratory and authentic learning experiences). Their new mindsets prevailed even after several years of working as specialists, and they also improved their mathematical knowledge as they worked as specialists. This study demonstrated the effectiveness of providing training to those intending to become mathematics specialists.

Furthermore, almost all states have certifications for reading specialists, whereas less than half have them for mathematics specialists. Certain states are considering mathematics specialist endorsements and others have certification guidelines (Ellington et al., 2017). States have begun to establish pathways for endorsements like Georgia where a K-5 Mathematics Endorsement is offered to certified teachers (Swars et al., 2018). However, more often than not, most elementary mathematics specialists enter into their roles without any formal training.

Existing Research

In comparison to studies that examine the role of literacy instructional coaches, there is minimal research on how mathematics coaches can support teachers (Lachner &

Nückles, 2015). The following describes several significant studies related to mathematics specialists.

Some research has presented qualitative descriptions of what a math specialist does during a workday. In one notable qualitative study, Ball, Hill, and Bass (2005) observed seven mathematics coaches for 1-2 days using observation templates, field notes, and questionnaires. They aimed to learn what the mathematics coaches' day-to-day job consists of, what was addressed during coaching sessions, and the interpersonal dynamics between coaches and teachers. Researchers looked at eight aspects of coaching: assessment, communication, leadership, relationships, student learning, teacher development, teacher learning, and teacher practice. They found that coaches use a model of pre-conference, observation, and a post-conference debriefing; in this manner, coaching happened both formally and informally. Their communication included exchanging information, facilitating teacher learning, and building relationships; their styles also changed from collaborative to directive. They also adopted various roles including teaching, serving as lunch monitors, and managing data.

Other studies examined the skills a coach needs to develop in order to be effective. Hartman (2013) conducted a case study of one first-year math coach in a school located in a rural town during the 2010-2011 school year. This coach had been a respected math teacher for 8 years before stepping into her position. This coach was able to develop better working relationships with fifth grade teachers than the seventh grade teachers. The author attributed both her successes and failures of getting access to teachers' classrooms to her ability to form relationships with individual teachers. The topics of "insider status, coach identity (especially in transitioning from a teaching to

coaching role), trust, staff connections, and teacher resistance" were cited as factors that affect whether or not a coach is able to "gain entry" (p. 57). A coach needs to be viewed as capable from her colleagues' perspectives, become a part of the community, and build confidentiality and trust.

Several bodies of research include anecdotal accounts. Walkowiak (2016) wrote of her own experiences as a math coach and advised five practices including having a clearly defined role, establishing trust with teachers, valuing teachers' ideas, setting clear goals, and reflecting on evidence of student learning. Similarly, Zuspan (2013) examined the reflective journaling data of a mathematics coach who initially felt isolated in her role, which was not clearly defined, and subsequently started to build rapport and trust with her colleagues. Fennell et al. (2013) also focused their study on anecdotal accounts of coaches with different roles and provided a bullet point list of tasks/recommendations. The important components include that coaches need to know how to teach adults, develop rapport and relationships with colleagues, support the individual needs of teachers, adapt to a new culture, set meetings, design one-on-one or large professional development, use resources, improve math programs, and have leadership skills.

Additionally, Chval et al. (2010) examined 14 high-performing teachers (with 7 to 28 years of experience teaching) becoming new mathematics K-7 specialists and their shifting identities of coach as supporters of teachers and students, as learners, and as supporters of school-at-large, as well as how they negotiated roles with teachers and administrators. Authors used surveys, interviews, written prompts, coded whole-group discussions, and pie charts to show how they used their time. The researchers examined the coaches' initial expectations of roles and actual roles; their self-identities and

feelings; their relationships with teachers, administrators, and parents; their navigation of expectations of being both experts and learners; their expectations of relationships; and the difficulties and barriers they may have experienced.

Researchers Gibbons et al. (2017) studied an experienced math coach who led and organized collective professional development sessions as well as differentiated individual coaching for teachers in an underperforming school. The teachers were asked to relocate if they did not want to participate in the program and the math coach was able to work with teachers who were amenable to her involvement, a principal who was involved and supportive, and a structure that allowed for collaboration. Through leading sessions to examine standards, co-plan instruction, observe instruction, and reflect with her team, the staff began to use common language by year two. By year four, student scores had increased significantly. Essentially, the coach as well the team gradually converged in their instructional beliefs and implementation and effectively achieved school wide reform.

Finally, a study conducted by researchers Hopkins et al. (2013) examined a suburban school district in Illinois for 3 years (2010 to 2012) as they selected, trained, and supported elementary math coaches. Schools selected classroom teachers who had an affinity for teaching math as well as a good rapport with their colleagues. These teachers went through a university partnership training for a math specialist certification as well as training for a new mathematics curriculum. An important part of this implementation was that the districts ensured alignment with current infrastructures; coaches were brought into training during already established professional development hours and continued to use previous databases of information. Although these coaches also had classroom

responsibilities and their hours available for coaching varied significantly by school, their colleagues increasingly saw them as the go-to people for mathematics pedagogy information due to their formal training as well as their position and responsibilities of leading professional development. Researchers noted that these interactions encouraged a change in teachers' mindsets about mathematics pedagogy and beliefs regarding inquiry-based approaches. Although this study lacked data on how effective this practice was in terms of student outcomes, it demonstrated that math coaches/specialists can become a stronger source of collegial support in curricular change when they are carefully selected, supported, and trained.

Overall, there is a lack of empirical research on how mathematics specialists support teachers (Chval et al., 2010; Walpole & Blamey, 2008). A lack of extensive research into what makes an effective math coach can be attributed to the fact that this position has gained popularity relatively recently, in comparison to literacy coaches (Walkowiak, 2016).

Necessary Factors for Accomplishing Reform

Leadership skills and collaboration. When a teacher transitions into coaching position, he/she needs to navigate a new role in a complex social system, including himself/herself, others, the institution, and cultural factors, along with established policies, which takes time to learn to manage (Smith et al., 2017). Math specialists need to know how to manage and negotiate interactions with teachers effectively (Mudzimiri et al., 2014). Specialists need to be able to employ a unique type of leadership, one that is collaborative, supportive, and built on trust rather than a type of leadership that is evaluative or tied to hiring decisions. They need to serve as agents of change who transfer

information and include all teachers (regardless of their instructional capabilities, status, or even willingness to participate) and facilitate interactions that catalyze change (Hopkins et al., 2013, 2017).

Often, math coaches need to organize and lead effective professional development in collaborative settings as well as provide individualized and differentiated coaching to improve teachers' understandings of content knowledge, pedagogy, and curriculum (Gibbons et al., 2017; Hopkins et al., 2013). In this manner, one needs to gauge quality of instruction; reflect on the limitations and strengths of teachers in their content knowledge, pedagogical skills, and beliefs regarding students; and create experiences to encourage an internal and instructional shift toward a common goal (Gibbons et al., 2017).

Knowing how to organize and lead collaborative efforts is important because teachers need opportunities to collaborate in order for successful educational reform to occur (Franke et al., 2001). This is because education reform is implemented through teachers who make instructional decisions and decisions regarding how they will or will not change their teaching practices (Bridwell-Mitchell, 2015). Essentially, reform is a social process (Gibbons et al., 2017; Hopkins et al., 2017). Collaboration can allow for a reshaping of identities and beliefs through the sharing of new ideas and creating new frameworks (Battey & Franke, 2008). According to Bridwell-Mitchell (2015), teachers need to be able to collaborate with each other, have a feeling of social cohesion as well as access to diversity and new ideas, learn better teaching strategies from their colleagues, and converge their teaching practices to align with those of their colleagues. These conditions of institutionalized reform are difficult to establish, and one needs to identify

the components that need to be improved and address them intentionally in order for teaching practices to improve within a school.

In order for teachers to improve their teaching practices, they may need to change their identities and beliefs regarding themselves and their students' abilities (Battey & Franke, 2008; Gibbons et al., 2017). This is because teachers' sense of identity regarding themselves (e.g., as being structured and methodical or unknowledgeable in math content) as well as others (e.g., people being either math-people or not) shape teaching. These perceptions also affect their participation in collaborative settings with colleagues (Battey & Franke, 2008). In this manner, a coach needs to know how to establish goals and encourage mutual understanding about mathematics instruction (Gibbons et al., 2017).

Even though specialists may be knowledgeable and capable of teaching mathematics, they cannot be leaders until they have earned the professional respect of other teachers and are seen as being approachable. To do this, math specialists need to develop interpersonal skills that allow for collaboration and influence on teachers' instructional practices (Campbell & Malkus, 2013).

Overall, in order for learning communities to be effective, educators need to collaborate, share responsibility for student outcomes, and reflect; additionally, these communities need to be sustained by the participants (Watson, 2014). Having a mathematics coach/specialist overseeing professional development and continually supporting colleagues through collaboration can address these needs and create changes in instruction (Gibbons et al., 2017; Zuspan, 2013). These are challenging skills that math coaches need to acquire and hone in order to be effective in their role.

Clarity of role. Administration also needs to support coaches by setting clear goals and expectations; the support of administration along with an established culture of collaboration is essential to the success and growth of a math coach (Gibbons et al., 2017; Hopkins et al., 2017; Neumerski, 2012; Zuspan, 2013). Accordingly, role ambiguity, a lack of clarity in goals, lack of support from administration, as well as an isolating culture can become obstacles for mathematics specialists. Without an existing collaborative culture within a school, math coaches can be limited in their ability to effect change because they need to communicate and collaborate with teachers in order to effect instructional change (Gibbons et al., 2017; Hopkins et al., 2017; Zuspan, 2013).

Culture. Math coaches are hired to help improve as well as change their colleagues' instructional practices; this type of instructional change is difficult to achieve (Campbell & Griffin, 2016). Often times, instructional coaches walk into a school culture that has been firmly established prior to their hire. For example, a school may have a culture of isolation where teachers do not collaborate with each other (Battey & Franke, 2008). A lack of collaborative culture within a school can limit math coaches' ability to facilitate interactions and work as agents for change (Hopkins et al., 2017). In a more extreme case, the administration can mandate teacher participation or encourage job relocation if they choose not to, ensuring that the staff works with the coach (Gibbons et al., 2017). Having a previously existing embedded infrastructure—or creating one—to provide time for collaboration can promote the fostering and exchanging of ideas necessary for changes in teachers' beliefs and practices (Gibbons et al., 2017; Hopkins et al., 2013). Thus, it is vital to create a collaborative school culture in which math coaches can transfer information and lead through collaboration (Hopkins et al., 2017).

Long-term support and organizational structure. When schools and school districts hire mathematics specialists, they must also make a long-term investment in the coaches' growth and professional development (Hopkins et al., 2017). This is because as mathematics specialists understand the culture and increasingly build relationships with teachers, they are able to become more effective over time (Gibbons et al., 2017; Hopkins et al., 2013). Additionally, coaches need to be given opportunities to collaborate with teachers in order to be catalysts for instructional reform (Hopkins et al., 2013, 2017). As the coaches work with teachers, they need to continually develop their own understanding and abilities to support teachers as math coaches (Campbell & Malkus, 2014).

This improvement may be in the form of increased collaboration, a mutual understanding of mathematics instruction, an improved mindset in the capabilities of all students in their ability to learn, and even a gradual increase in test scores (Gibbons et al., 2017; Hopkins et al., 2013). Specialists are able to build collaborative relationships in order to impact mathematics teaching of their colleagues and improve mathematics outcomes for their students over time. Therefore, it is necessary to have a systemically coherent and long-term strategy to support coaches through providing professional development to coaches (along with their leaders and teachers) and opportunities and time for learning, cultural and social development of collaborative networks and continual support (Hopkins et al., 2017).

Overall, effectiveness develops over time as mathematics specialists and staff work and learn together (Campbell & Malkus, 2013; Hopkins et al., 2013). Math coaches need long-term support aligned to the instructional goals of the school and must receive

opportunities to attend professional development and further their learning (Hopkins et al., 2017)

Conclusion

With the adoption of new standards, expectations of elementary mathematics educators are changing. The nature of mathematics education is becoming more rigorous and focused on authentic learning experiences. Teachers need to keep up with these changing expectations and ensure that students are receiving the best education so that they are able to compete globally. In this manner, teachers need to learn and grow continually in order to serve as capable educators and accordingly, schools are seeking out ways to provide this support.

The research states that having elementary mathematics specialists in a school building is the most effective way to support elementary teachers in developing their content and pedagogical knowledge. Having a math specialist on-site was shown to be more beneficial than sending teachers to large-scale and/or short-term professional development sessions that are not differentiated to address their specific needs. Unfortunately, talented math teachers are often asked to take on mathematics coaching roles without any formalized training.

The role shift from teacher to specialist offers challenges for which new mathematics coaches are unprepared, including having to develop additional content and pedagogical knowledge and collaborative-leadership skills. Understanding this transition from teacher to specialist could provide essential information regarding the skills mathematics specialists need to acquire in order to become effective in their roles.

Having this information would assist those stepping into the new role of mathematics instructional leadership.

Chapter 3: Methodology

The goal of this study was to learn about the process of transitioning from full-time teaching positions to elementary math specialist positions in independent schools by through hearing the stories of these professionals. This study addressed the following research questions:

1. According to the mathematics specialists, what did they have to learn in terms of content knowledge, pedagogical skills, and relationship-building and leadership skills?
2. According to the mathematics specialists, what were the challenges and support systems present at their school sites?
3. According to the math specialists, what was their initial intended purpose for their roles, and how has this changed, if at all?

Research Design and Rationale

Design and methods. A qualitative study was appropriate for understanding the process of transitioning from teaching mathematics to coaching in independent elementary schools around Southern California. In this manner, this study was intended to learn about the subjective views of transitioning into a new role; therefore, a qualitative study was the most suitable approach (Merriam & Tisdell, 2016).

This study was not intended to measure the effectiveness of mathematics specialists or student outcomes. Instead, I aimed to understand the participants' unique experiences and views by learning their stories on transitioning into their roles within the context of their worksites. In order to achieve these goals, a qualitative study design was most appropriate (Maxwell, 2013; Merriam & Tisdell, 2016). The goal was to capture

each context, point of view, and experience of the mathematics specialists in all of their richness.

Strategies of inquiry: Site selection and population. This study focused specifically on independent schools, which can be different from public schools. About 10% of primary and secondary students in the U.S. attend independent schools (Marlow, 2010). Although some reformers continue to try to improve the education system through raising standards and accountability measures, others aim to increase competition and choice between schools by offering choice, like independent schools (Belfield & Levin, 2002). It is valuable to examine how independent schools utilize math specialists to understand the possible intention of hiring a math specialist as well as the pressures and expectations these specialists may face.

Independent schools are unlike public schools in that they are not regulated by the state. There is a negative correlation between enrollment in independent schools and performance in public schools, indicating that parent demand for independent schools increases with lower performance of neighboring public schools (Belfield & Levin, 2002; Marlow, 2010). Parents who choose to matriculate their children in independent schools need to pay an additional tuition fee on top of their tax dollars, essentially double-paying for school. This may financially incentivize independent schools to outperform public schools as well as attract students and parents who are more academically competitive and financially wealthier. Additionally, students are assessed through different exams than public schools. Often, students are pressured to test into independent middle schools, and in this manner, the expectations and pressures on educational professionals in independent schools and educational goals may differ from those in public schools.

Overall, students enrolled in independent schools tend to outperform public schools on standardized tests (Marlow, 2010). Although it is possible that higher-performing students are being moved into independent schools through their parents' choice, there is little evidence in the literature to indicate that the students moving to independent schools are performing better than their public school peers (Belfield & Levin, 2002; Marlow, 2010).

Moreover, there are differences between independent schools, and expectations as well as student outcomes can vary significantly. Most independent schools in the United States are Catholic schools, and most religiously affiliated schools offer a tuition subsidy (Marlow, 2010). These schools offer religious classes that are not directly related to improving student performance on standardized exams (Belfield & Levin, 2002; Marlow, 2010). Secular independent schools usually charge a higher tuition and are focused on college preparation (Marlow, 2010). Furthermore, the resources available to independent schools' mathematics specialists in terms of financial support and training may vary, and the manner in which specialists need to manage relationships (with students, teachers, administrators, and parents) can be distinctively different from public schools.

In order to select math specialists in independent schools, I obtained a comprehensive list of independent schools in the area through the organizations Los Angeles Independent Schools (LAIS), California Association of Independent Schools (CAIS), and National Association of Independent Schools (NAIS). I contacted a colleague at UCLA who is an administrator at an independent school and obtained a comprehensive list of schools in NAIS. Additionally, I was able to search for schools on the CAIS and LAIS websites. I included schools within the city of Los Angeles and the

surrounding areas including southern and western regions like the Pacific Palisades and northern regions including Valley Glen. Although there were overlaps in the listings, NAIS and LAIS had about 15 more schools listed than CAIS. Overall, I identified 64 independent elementary schools.

After identifying these independent elementary schools, I examined their websites to see if they had a math specialist. If this information was not presented, I called the school and/or sent an email communication. Certain schools had a director of curriculum overseeing all elementary content areas including mathematics, and I excluded those holding such titles from this study because these positions are distinctly different from a position of a mathematics specialist. If the schools had a math specialist, I recorded their names and email addresses. From the 64 schools, I identified 25 schools with math specialists in independent elementary schools across the Los Angeles region.

Next, I began to email specialists to see if they would be interested in participating in my study. I also asked participants to give me referrals to other specialists they knew who might have been interested in participating. This allowed me to identify other specialists that I had missed or were new hires to their positions.

My ultimate purpose in selecting the participants was to obtain a heterogeneous representation of independent schools (Maxwell, 2013). A unique characteristic of independent schools is the variability of the demographics and institutions due to a lack of government regulations. I was interested in learning about the experiences of participants who work in religiously affiliated as well as secular schools, single and mixed gender schools, those with a high minority population and those predominantly serving a homogenous population, and those with relatively higher and lower tuition

rates. My intention was to capture the variety of experiences of math specialists working in independent schools. Most of these professionals were officially referred to as mathematics specialists in their work settings. They carried out different roles including coaching, teaching, conducting data analysis, and recommending curriculum, in addition to managing relationships with teachers, administrators, students, and parents. Overall, they were responsible for leading their mathematics departments. Furthermore, I aimed to learn the reasons for their hiring through my interviews and whether or not their initial reasons for hiring diverged from their actual roles.

The next section describes the process via which I was able to gain participants for my study.

Screening

Initially, I had identified 31 potential candidates and called them individually for a short, five-minute screening phone call. Out of these professionals, six were eliminated from the candidate pool because they recently had a change in position (through a promotion to a full-time administrative role or a change in school and position) from the previous academic school year.

Consequently, 25 mathematics specialists were identified as being suitable candidates for participation. I was able to hold 5-minute screening interviews with 21 of these candidates. Although I planned to recruit at least 15 mathematics specialists, I was able to obtain a total of 16 interviews of specialists in independent elementary schools in Southern California and interview them in the order in which they agreed to participate. One candidate was able to participate in an in-person interview and the rest opted to be interviewed over Facetime or Skype. The participants were asked to bring two artifacts

that they viewed as impactful or helpful for them professionally, that represented why they do their job, or that held professional significance for them.

Participants

The stories of these 16 math specialists offered snapshots of the various stages of being a math specialist, from their first years in the profession to their admitted final year in their current position. Although they all held various titles, I was able to confirm with them that they would describe their roles as being an elementary math specialist. Table 1 presents background information on the participants, including past experiences and current positions.

Table 1

Professional Background Information of Math Specialists

Pseudonym	Years Working in Education	Years as a Specialist at Current School	Full-time or Part-time	Grade Levels	Math Specialist at Current Site	Religious Affiliation of School
Laurie	25	6	FT	3-6	2nd	NA
Kathy	24	3	PT	2-12*	1st	NA
Ted	19	5	FT	1-6	1st	Episcopalian
John	18	1	FT	TK-6	1st	NA
Deidre	17	7	FT	K-6	3rd	NA
Mill	16	3	FT	2-6	2nd	NA
Hillary	15	1	FT	K-6	2nd	NA
Vicky	15	3	FT	K-6	1st	NA
Rebekah	13	3	FT	K-6	2nd	NA
Natalie	13	3	PT	PK-6	1st	NA
Elise	13	3	PT	PK-6	1st	Episcopalian
Landon	12	3	FT	K-6	2nd	NA
Sherrise	10	2	FT	1-6	3rd	Episcopalian
Jenny	7	2	FT	K-5	3rd	NA
Orena	1	1	FT	1-6	2nd	Jewish
Kitty	1	1	PT	3-5	2nd	Jewish
Median	14	3	4PT, 12FT		2nd	

Previous experiences. The 16 participants held a broad range of previous experiences ranging from first year educators (Orena and Kitty) to a professional in her 25th year in education (Laurie), with a median of 14 years. Their experiences in education varied from having extensive experience training teachers in administrative and coaching roles, to those who taught in various school settings and content areas, to two specialists with no prior full-time teaching experience.

Current role. Their time in their current positions as math specialists ranged from 1-7 years, with a median of 3 years (supporting research that this is a relatively new position in the field of elementary education). All specialists worked with the elementary grade levels; nine of these specialists also worked with kindergarten and pre-kindergarten grade levels. One specialist, Kathy, worked with second through 12th grades; her unique role is discussed in greater detail in later sections. Overall, four participants were employed part-time and 12 were employed full-time at independent schools across the Los Angeles region: two schools affiliated with the Jewish faith, three affiliated with the Episcopalian faith, and the rest with no religious affiliation.

Professional Training, Degrees, and Prior Positions

Specialists' education levels ranged from a participant with his Doctoral Degree in Education Leadership (Ted), another with an "ABD" status (Vicky), to a specialist who had no credential or degree whatsoever in elementary education (Kitty). Aside from Kitty, all other math specialists held credentials in teaching. Participants had held previous full-time teaching positions within the K-12 education system (with the exception of Orena and Kitty). They had worked in elementary grade level teaching positions, secondary mathematics teaching positions, life skills teaching, athletic

coaching, and special education in a variety of settings including public schools, inner-city schools, charter networks, and independent schools in various states across the United States.

Three specialists—Ted, Hillary, and Sherrise—had previously held administrative positions. Hillary was certified in administration and worked as a Head of School in China as well as an instructional facilitator in an out-of-state public school, a position similar to a math specialist. When she worked in a position akin to a math specialist for her district, she received professional development training sessions for her job. Sherrise also held a degree in administration and had earned an official math specialist endorsement from out of state. Ted had worked for 10 years in administration at an independent school, although he held no specific administrative training or credentialing.

In addition to Hillary and Sherrise, Mill had previous experience in a similar position to a mathematics specialist. She worked as a math specialist for 5 years at another school in California, although she did not have specific math specialist training. Additionally, Vicky also had experience in coaching adults where she trained and supervised pre-service teachers while working on her PhD in curriculum and instruction with an emphasis in mathematics teaching.

In stark contrast, two specialists with the least amount of prior experience in education had no full-time experience teaching. Orena had just completed her certification in teaching through an alternative certification program for educators and was starting her first year as a full-time educator. Kitty had very limited experience and had only volunteered at another elementary school before getting hired as a part-time math specialist at her current school. She held no certification or degree in education, and

this was also her first year as an educator and math specialist. Both participants had previous experience working in the corporate sector and both worked at independent schools affiliated with the Jewish faith.

Eight participants had been employed previously at their school sites as teachers prior to their transition into a specialist role. One participant, Deidre, had been a student, teaching assistant for another math specialist, and a grade level teacher and her entire teaching career of 17 years was with her current school. These professionals were familiar with the culture of their school and had formed relationships prior to entering into their current positions. The other half of the participants entered into their positions without any prior experience at their worksites.

Data Collection Methods

To address my research questions, I conducted interviews and artifact analysis. Through a short phone call, I screened and invited potential participants for an interview. During this phone call, I collected a few pieces of demographic and job-related information, including the specialists' prior experience, the grade levels of teachers with whom they worked, as well as the grade levels of students they taught. This allowed me to gain some background information prior to the interview, and I was able to ask more meaningful questions during the actual interview.

During the interview, I asked the specialists about their preparation for the position when they were initially hired, and how clearly defined their roles were. Additionally, I tried to understand the initial goal of their hiring and how these goals as well as their roles may have changed throughout the years. Furthermore, I asked the participants what they had to learn in terms of content, pedagogy, and leadership skills

throughout their work as mathematics specialists and whether their initial roles had changed over the years. I wanted to know if these learning opportunities were in the form of formal professional development, through the structure of their positions, or through people who may have encouraged them in their growth. I aimed to understand how these professionals were able to gain the knowledge and skills necessary for their positions. I asked them about the challenges they faced in building these skills in order to learn what factors and people hindered or fostered their growth.

Finally, I tried to understand how they built and managed relationships. I inquired about their relationships with teachers, administrators, students, and parents and the challenges and support they may have received from these people. I aimed to learn how these relationships evolved and how the specialists also evolved in order to work with and accommodate these individuals' needs.

Overall, I intended to understand their stories, so I asked prompting questions such as, "Tell me about that" and "What happened then?" in addition to the questions prepared for my interview. Additionally, I hoped that my own role as a math specialist would foster empathy between myself and the participants and encourage a candid conversation. (See Appendix B for my interview questions).

Finally, I asked mathematics specialists to bring two items that helped them in their practice and asked them to respond to a series of questions that fell under several categories. In order to address research question 3, I asked about their current positions, previous experiences, as well as their current roles. This allowed me to understand how their positions had evolved throughout the years. Next, the questions regarding content, pedagogy, and leadership learning helped me to address research questions 1 and 2. The

questions probed at support systems, challenges, and relationships the specialist had to manage as they grew in their roles. Furthermore, the artifacts gave the mathematics specialists an opportunity to provide additional information regarding their professional growth that may have been otherwise missed.

Procedures. I recorded the hour-long interviews with my laptop as well as another recording device, an Olympus digital voice recorder. I used rev.com to transcribe the interviews and I emailed participants when small clarifications needed to be made.

Data analysis. In order to analyze the interview data, I transcribed the interviews and read through them all prior to coding. Additionally, I used an Excel spreadsheet and Quirkos to organize the categories of coding.

Before analyzing data gleaned from interviews, I created profiles of the mathematics specialists who were interviewed, including the kind of school they at which worked, their experiences and responsibilities, and grade levels with which they work. More specifically, I wanted to know which grade levels the specialist supported, whether or not the specialists taught students, religious affiliation of the school if any, prior experience in a similar role as well as years in their current role, and what their current role comprises. Gaining this data prior to coding allowed me to have data to use when looking for commonalities or differences in the responses of certain specialists whose profiles were similar or different.

Although my interview questions were designed to fall distinctly under the three research questions, coding the interview data by question did not make sense and appeared disjointed. After several attempts at trying to impose these categories, I decided to put aside my research question categories and coded data with fresh eyes to see what

would emerge. This approach allowed me to identify categories and themes that were unexpected, and a story of the math specialists' professional evolution started to come together. The broader categories were moments of change, which included their moments of hire, challenges, learning, and changes in roles.

In analyzing moments of hire, I learned reasons why the specialists were hired by their schools as it was explained to them during this process. Several categories emerged, from being hired to replace a former math specialist, to supporting teachers with instruction or a curriculum change, to teaching students, among others. These emergent categories allowed me to examine the purposes of research question 3, which was to learn what their intended roles were and whether they eventually changed.

Next, I coded for the types of challenges math specialists faced. There seemed to be a difference in challenges between specialists who had worked as teachers at their current worksites and were hired internally versus those who were external hires. Furthermore, some second-time specialists seemed to struggle more, given their previous experiences. Additionally, I examined data for specialists' views on how they saw themselves in their new roles and whether or not they identified as leaders. I also examined the advice math specialists would hypothetically give to new, incoming specialists either at their school or at another school. By coding for these questions, I was able to address my research question 2 to analyze what challenges they faced.

Next, I analyzed the category of learning, relationships, and negotiations. Math specialists spoke of continuing to develop mathematics content and pedagogical skills through seeking professional development and learning opportunities, learning from other teachers, and independent learning. Responses to questions pertaining to relationships fell

under the categories of having to build relationships with teachers through a non-evaluative role as well as managing challenges and successes with teachers, administrators, parents, and students. These categories addressed research question 1 and addressed what specialists had to learn through their roles.

Finally, I examined specialists' actual roles and responsibilities to see if there were any changes from what was initially expected. The most common roles that math specialists took on included teaching students, coaching teachers and leading professional development, using data to improve instruction, and managing and working with parents. There were some unique roles that needed to be addressed, and the manner in which their roles changed provided surprising insights. Their responses in this category coupled with the reasons for hiring provided insight into research question 3 and whether or not their roles had changed.

In this manner, using categories that were moments of evolution for math specialists provided a progressive depiction of how math specialists learn and grow through their roles over time.

Interrater reliability. In order to determine interrater reliability, I gave my professor at UCLA a copy of one interview transcript and my coding categories along with a brief description of each category. My professor coded the interview and I checked her codes with how I had coded the same interview. There was a significant match, which allowed me to confirm interrater reliability.

Role Management and Ethical Issues

The participants in this study held positions similar to the one I hold at my workplace. I did not believe there was a conflict of interest because my interview

questions were focused on the specialists' experiences rather than on their strategies to help students gain admission into competitive middle schools. Finally, I did not hold any authority or supervisory role over these professionals. In this manner, my professional role did not serve as a conflict of interest or present an ethical issue as I carried out my role as a researcher.

Credibility and Trustworthiness

Prior to conducting my study, I informed the participants of the goals of my study and explained both my professional and academic positions. Since I have my own experiences in transitioning from a full-time teaching position to a math specialist position at an independent elementary school setting, I had my own biases and expectations regarding this process. In this manner, I kept in mind that researcher bias could color my perceptions when analyzing data (Maxwell, 2013). While interviewing other math specialists, I adhered to my interview protocol and did not ask leading questions or offer possible answers to questions. I tried to remember to avoid taking sides or commiserating with the mathematics specialists. Also, I made sure to respect their privacy and kept their identities confidential by using pseudonyms instead of using the actual names of people and schools. Additionally, follow-up interviews and communication ensured further validation as well as clarification (Merriam & Tisdell, 2016). These factors helped to address possible ethical issues of my study (Creswell, 2018; Merriam & Tisdell, 2016).

Summary

From my experience, transitioning from a teaching role to a specialist role was difficult, especially without formal training or mentorship. This seemed to be a common

experience in which passionate educators struggled once again to learn how to assist adults and manage relationships as math specialists, while having to learn quickly in order to be effective in their roles. This study on what mathematics specialists of independent schools had to learn while transitioning into their new roles could help others who intend to do the same. Hopefully, this study may be able to serve as their guide when needed.

Chapter 4: Findings

The goal of this study was to learn about the process of transitioning from full-time teaching positions to elementary math specialist positions in independent schools through hearing the stories of these professionals. This study addressed the following research questions:

1. According to the mathematics specialists, what did they have to learn in terms of content knowledge, pedagogical skills, and relationship-building and leadership skills?
2. According to the mathematics specialists, what were the challenges and support systems present at their school sites?
3. According to the math specialists, what was their initial intended purpose for their roles, and how has this changed, if at all?

Summary of Key Findings

Findings from this study revealed progressions over time in specialists' knowledge, skills, and roles as they faced challenges and learned to manage and build relationships. Although the questions I asked the participants throughout the interviews were designed to answer three distinct research questions, the seemingly disparate pieces of data came together to tell a story of these professionals' evolution. These moments of evolution included their initial hiring, managing challenges, learning, and adopting new roles. Ultimately, as math specialists built relationships and identified needs of the school, they would begin to act to address these needs and carve out their own roles, which would be a discernible indicator of their success in creating impact.

Specialists' previous experiences played a role in shaping both the manner in which they were hired and what they would need to learn in their new roles. Most specialists had former experience as teachers, even administrators, prior to assuming their position, with the exception of two specialists who had no prior experience leading a classroom full-time (one of which had not been trained as an educator). Commonly cited purposes of their hiring were to replace a former math specialist, to support teachers with instruction, to teach small groups of students, and to support a transition to a new Common Core aligned curriculum.

Data showed that it is a common experience for mathematics specialists to enter into their roles without any formal training for their positions. These challenges included having to teach new grades with which they were unfamiliar; negotiating and managing relationships with students, teachers, parents, and administrators; working with challenging school cultures; and grappling with their own self-perceptions. Challenges related to building relationships with teachers were different (and relatively easier) between specialists who had worked previously as teachers in their current sites and those who were new, with the former having already established relationships and an understanding of school culture. Overall, the challenges they faced indicated the types of learning they would have to do in order to be successful in their roles.

Relationship building was a necessary and foundational skill for math specialists. Participants spoke of having to learn how to manage professional relationships with teachers, administrators, and parents as well as managing their own self-perception as instructional leaders. They also learned how to teach students of grade levels with which they had never worked previously, and in order to do so, they sought out learning

opportunities by attending professional development sessions and conferences, reading and researching independently, learning from teachers with whom they work, and forming a learning group of math specialists from other independent schools called the Mathematics Consortium. Furthermore, specialists spoke of having to learn how to present their ideas and negotiate with colleagues as well as school culture in order to create changes in how mathematics is taught in their schools. The specialists who were most successful included those who had a prior professional relationship with the school regardless of their previous experience, and even those with the highest education level and greatest experience struggled with building relationships.

Their roles changed from their original purposes as they provided support to teachers in becoming more self-sufficient with the new curriculum, spearheaded new programs for professional development and teaching students, and managed successes and setbacks in pitching their ideas and forging relationships. For most of the specialists, their roles would expand to include teaching groups of students, coaching teachers in meetings and professional development sessions, managing parents, and using data to inform instruction. The specialists who were successful in building relationships were able to take their ideas and impact the mathematical instructional practices of other teachers as well as change and add to their own roles.

The following sections explain these findings further.

Purposes of Hiring a Math Specialist

Math specialists were asked why their schools hired them for their position to provide insight as to what their initial roles were meant to accomplish. Coupled with

descriptions of their actual roles, which is discussed later, this initial questioning allowed for a comparison to ascertain if any changes were made in their roles.

Table 2

Reasons for Hiring Math Specialists

	Previous Experience at Current School	Replacing Former Math Specialist	Support Teachers with Instruction/ Curriculum	Teach Small Groups of Students	Support Teachers with Curriculum Change	Created Own Role	Following Trend of Having Math Specialist	Manage Parent Relationships	Improve Student Scores
Rebekah	Teacher	x	x	x	x			x	
Natalie	Teacher		x			x			
Elise	Teacher				x	x		x	
Landon		x		x	x				
Orena	Parent	x							
Ted	Teacher		x		x				
John				x			x		
Mill		x	x						
Hillary		x		x	x				x
Laurie	Teacher			x		x			
Vicky			x						
Kathy	Teacher					x	x		
Kitty		x		x					
Sherrise		x	x		x				
Jenny	Teacher	x	x						
Deidre	Teacher	x	x	x					
Total	8T, 1P	9	8	7	6	4	2	2	1

The most common reasons math specialists heard for their hiring included (a) to replace a former math specialist (which pertained to nine [56%] specialists), (b) to support teachers with mathematics instruction (eight specialists), (c) to address an adoption of a new curriculum (six specialists), and (d) to teach students in small, differentiated groups (seven specialists). Less common reasons included managing parent relationships (two specialists), keeping up with the trend of hiring math specialists (two specialists), and addressing student performance on standardized exams.

Four specialists even played a major role in creating these positions for themselves and identified a need for a math specialist at their school. They pitched the idea to their administrators, citing needs of their school as well as personal reasons; this subject is discussed later. There were also variations in how these professionals began their roles, including eight who were hired within their schools and one who had built relationships as a parent of a child attending her school. Eight specialists (including the specialist who was a parent) had no prior experience working with their schools and seven specialists had no prior experience and had little familiarity with their current school sites' staff or culture upon hire. (Whether or not they had previous relationships at their schools would significantly influence other aspects of their work, including their learning, which is discussed in later sections.)

Although there were differences in the manner in which the math specialists were hired, there were commonly shared purposes of hiring a math specialist among independent schools. The following sections provide additional details regarding the reasons for hiring.

Hired to replace a former mathematics specialist. Nine specialists were hired to replace former math specialists who had either left their school or were promoted into an administrative role within their schools. Rebekah mentioned that her previous math specialist was not the best fit for her school and Deidre's administration wanted someone with a stronger number sense than her predecessor. Jenny and Landon replaced specialists who were promoted into higher level administrative positions. There was no noticeable pattern in how these nine specialists fell into the other categories.

Two specialists (Orena and Sherrise) mentioned that their predecessors had attempted to serve in their roles in both language arts and mathematics and were ineffective; therefore, the math specialist position was opened up for them. The other five specialists mentioned that the previous educator left because they were not a good fit for the role or decided to retire. Out of the nine specialists hired to replace former specialists, six (with the exception of Rebekah, Deidre, and Jenny) had never been employed at their current worksites. Although Orena was previously a parent of a student as well as a synagogue member, she had never had a professional working relationship with the staff.

Hired to teach students in small groups. Seven of the 16 math specialists mentioned that they were hired to teach students, and administrators made this reason explicitly clear to them when they were hired. Kitty stated she knew that she would teach a section of "third, fourth, and fifth grade math," and Landon stated that "they needed someone else to teach small groups for those students that needed extension or supports" to provide for additional differentiation. Five of these seven specialists were also hired to replace a former specialists, thus taking on a teaching role left open by a predecessor. This replacement meant that the manner in which the previous specialist carried out the role was also intended in their initial hire.

Although only seven of the mathematics specialists were initially made aware that a significant portion of their work would entail teaching students, more math specialists found themselves in this position and were surprised at how much teaching they would have to do. This finding is elaborated in a later section.

Hired to provide instructional support to teachers. Eight math specialists were hired to provide instructional support to teachers, which would mean their roles included

leadership responsibilities greater than that of a teacher. Natalie's school had a high turnover of teachers and:

> they weren't getting the sufficient training they needed in Singapore Math… so [they] thought [she] could be an on-site person to help facilitate that and see that [the teachers] have consistency amongst the grade levels in how [they] teach math in that curriculum.

She was one of the specialists (out of four) who took part in creating their own roles, and her argument persuaded administration to create this position for her. Natalie stated, "Our director of curriculum...didn't have proper training in our math curriculum because we do teach a specialized type of math… So having someone who had training and experience in teaching the curriculum I think was important to them."

Furthermore, Jenny was hired to "work with teachers and to make sure that [their] curriculum follows a clear scope and sequence from K-5th grade. Because although [teachers] use a single curriculum, Math in Focus, every teacher use[d] it in different ways." Therefore, her role was to ensure that "if something [was] skipped in second grade due to time, third grade [was] teaching that content area. If a specific class [was] weak in an area, that it [was] being remediated."

Out of these eight, only two (Deidre and Rebekah) were told they would teach a small group of students (a response category totaling seven specialists) and five replaced former specialists (nine). Only three were hired to support teachers through a curriculum change (six) and five math specialists were hired to support teachers. In this manner, these specialists entered into their positions knowing that their roles would entail working with teachers, which would expand their influence through coaching.

Supporting teachers through a curriculum change. Six specialists mentioned that they were hired to support grade level teachers through a transition of adopting a new mathematics curriculum. Each of these schools adopted a version of Singapore Math, a Common Core Standards aligned mathematics curriculum. They were tasked with providing teachers instructional support, bringing in adequate professional development, teaching students, as well as helping parents feel comfortable with the transition.

Hillary, a former administrator, was specifically hired for her expertise in mathematics instruction and was asked to research and choose a new mathematics curriculum for her school. She designed a way to implement the adoption, which she chose to approach gradually through introducing the curriculum to one additional grade level each academic year. Rebekah mentioned that her school administrators:

> wanted to change math curriculum [to Singapore Math] after over 15 years of Everyday Math. So they knew that was going to be a big job getting the community on board, getting the teachers on board, and then ultimately implementing the program.

Ted, who was also a former administrator, was hired "because they felt like math was an area where teachers… could use additional support. And because… they were trying to transition into the new program. They needed somebody to help guide that process."

In this manner, the adoption of the Common Core Standards and changes in mathematics curriculum served as a reason for schools to hire these math specialists.

Hired within their schools. Eight math specialists had been employed within their schools as either elementary grade level teachers or a math teacher, including three participants who took on part-time specialist roles. These participants mentioned a level

of comfort in transitioning into their roles because they had already developed a familiarity with the culture, expectations, and had built relationships—this is discussed in greater detail later on. Additionally, they were recognized by their administrators for having a talent for teaching mathematics and for having an ability to work with other teachers, and they were promoted into their positions.

Hired due to talent recognition. Jenny was intending to leave her teaching position to develop her education therapist practice when the school offered her a position as a Lower School Director of Math Curriculum. Although she did not have specific teaching experiences or training in mathematics leadership, her school did not want to lose her as an educator and offered her this promotion. Jenny stated that she was recognized for having the kind of "personality that can work well with all grade levels and teachers" as well as being "good at teaching math, good at working with teachers and kids, [and administrators thought] she can do this position." (She has been in her position for 2 years now and is leaving at the end of the year to pursue her independent practice in education therapy.)

Another unique story is that of Kathy. She has held various capacities in mathematics education; she had a total of 24 years of experience as an educator and she had worked as a third grade teacher, elementary department head, and eighth grade teacher. Most recently, she held a part-time position as a pre-algebra and algebra teacher as well as a secondary math coach. Although she did not intend to work with the elementary school levels again, her administrators asked her to take on this role in addition to what she was doing. Although she had extensive experience at the elementary level, this is not her preference, and she was supporting elementary grades out of a

request to support teachers with instructional resources as well as to provide extra support for the newer teachers. She now works as a math coach for both elementary and secondary levels, serving grades two through 12.

Creating their own roles. Four math specialists (Natalie, Elise, Laurie, and Kathy) were former teachers who took part in creating their roles. Three of these specialists (with the exception of Laurie) worked part-time. (Only one other person, Kitty, was employed part-time; however, she had not been a former employee at her school.) Natalie, Elise, and Laurie considered leaving their positions for personal reasons (including having and raising children) and their administrators did not want them to leave. Elise stated, "I had been a classroom teacher and was actually leaving the school. They wanted to see what I'd be willing to do, so I presented it to them as a part-time position." Additionally, Laurie stated that she "presented the idea and the position was created for [her]... At the time, [they] only had one math specialist, and it became apparent [they] needed two… [Therefore, she] requested to become the [second] full-time math specialist."

These specialists negotiated a new position and pitched the idea of creating a part-time math specialist position, one their administrators obliged. This demonstrated that they had already built supportive and responsive relationships within their schools prior to accepting their specialists' positions. (Having these kinds of relationships at the time of hire would become important to them as specialists, and this is discussed further in later sections.) It was also notable that all part-time math specialists interviewed were female.

Hired to manage parent relationships. Rebekah and Elise, former teachers at their schools, were informed that they would work with parents in their roles at the time

of hire. Rebekah's role included "student support, parent support and teacher support." Elise and Rebekah both worked at schools with "a lot of pushback from parents [regarding their new math curriculum]... They felt like the teachers were not being trained, that they didn't understand how to teach it." Although only two specialists mentioned working with parents as an intended role, this would become a more common part of their actual roles, which is elaborated further in a later section.

Hired to keep up with the trend of hiring math specialists. According to John,

> [His administrators] felt like they were a little behind [in hiring a math specialist]... and [may have been] feeling the pressure of other schools in the area obtaining math specialists and realizing that was something they need[ed] to have to be competitive.

Additionally, when Kathy was negotiating her new role, it helped that her headmaster had worked with a math specialist at her previous school and "she wanted to try it out [at her current school]."

Hired to increase students' standardized test scores. Only one math specialist, Hillary, was informed that the intention of her hire was to improve student test scores—her school wanted to address students' performance on the standardized ERB (Educational Records Bureau) exams. However, many more specialists worked with data, which will be discussed later.

Conclusion. Overall, various reasons were provided to math specialists regarding why they were being hired, with the most common purposes being replacing a former math specialist, supporting teachers with instruction, teaching students, and supporting a curriculum change. As Landon stated, his administration "wanted [him] to help teachers

differentiate more in their classrooms… [by] teach[ing] small groups for students that needed extension or supports… [as well as] to help implement the new math program." In this manner, his reasons for being hired were multifold, similar to most specialists. However, as Landon and the other specialists would find out, their actual roles would change from their intended purposes and evolve over time. This change would happen as they faced challenges and learned to address them. The following section addresses the challenges these mathematics specialists faced.

Challenges

Types of challenges. All of the mathematics specialists in this study faced challenges throughout their tenure. Specialists who had been teachers or had some kind of connection with the school had an easier time transitioning because they had already formed relationships with school personnel. Two math specialists who had held similar roles had a tougher time starting over again at a new school. Furthermore, specialists struggled with their own self-perceptions as leaders and how they fit into their new roles. All specialists faced some kind of friction in their school and stressed the importance of building relationships.

Easier to transition within school. Eight math specialists had been employed within their schools as either elementary grade level teachers or math teachers. Out of these eight, one participant, Deidre, had been a student teaching assistant for another math specialist, and a grade level teacher; her entire teaching career of 17 years was with her current school. These eight specialists were recognized by administrators as competent math teachers who had the potential for leadership and relationship building. Elise stated that being a veteran teacher at her school helped her because, in her view,

teachers thought, “Oh, well she’s been here awhile. She knows what she’s doing,” which helped her to build relationships with teachers. When Jenny was promoted into this position, administrators saw her potential to be a leader, even if she did not see it in herself. As a teacher at her current worksite, in Jenny’s opinion, her administrators recognized her as “having the personality that can work well with all grade levels and all teachers” and “able to come into classrooms and provide support and resources in an organized way…that’s also not going to make teachers feel offended.” She also knew that the school culture was one that was supportive and had relationships with teachers. Regarding having held a former position at her school, Natalie stated, “I think it did help me because I think people knew, especially because I was the fifth and sixth grade math teacher… So, I think that gave me credibility.”

In addition to the eight specialists who taught previously at their schools, two specialists, Orena and Vicky, had personal ties to their schools before they started as math specialists. Orena was a parent of a child attending the school as well as a prominent synagogue member before she started her position. Additionally, Vicky’s husband was a personal friend of an administrator at her school, and this connection helped her to get a job offer while she was a full-time PhD candidate from out-of-state.

When assuming their role, in comparison to the six participants who had no prior connections, these specialists had a unique level of comfort in transitioning, and they were already familiar with the culture and community. In fact, they spoke about the culture of their school in a positive light in comparison to their counterparts who had not had previous roles in their current schools. Deidre described her school as a “tight-knit community,” Ted mentioned that the “community among the teachers is really special,”

and Elise stated that her worksite is a "sweet and kind school that has a close community." Orena, who was a former parent and not a teacher, also knew about her school community before joining as a specialist. She stated, "This is my synagogue, I have been going here since I moved to LA. And my kids go here." She commented that her workplace is a "collaborative environment" and management is conducted both "top down and bottom up." In this manner, specialists with previous experience within their schools prior to taking on the role of a math specialist had administrators who recognized that they had potential, both in terms of teaching and relationship building, and they were familiar with a community that was supportive of them.

The challenge of being a second-time specialist. Two math specialists, Hillary and Mill, had previously held similar roles in different schools. Regarding her former position, Mill stated,

> It was a very similar position. Only at my previous school, I had been a fifth grade teacher for several years before I became the math specialist. So by the time I transitioned into math, I had already gained the respect and credibility that I needed in order for teachers to trust me and know that they could rely on me. Took a few years though in the math position for me to gain the expertise that I needed to support them.

Both specialists described a prohibitive culture and having to build their reputations and relationships all over again. Hillary stated,

> You can't just do it the same way every school because it worked at the last school. So I think just first assessing the culture, relationship building, and not

> taking it personally when things don't go well, I think is something that is really, really important.

She noted,

> It's all has to do with the culture here. Historically, the old administrator was very lousy… The teachers could kind of do what they wanted, they weren't challenged. If they complained about something loud enough, they were just let go to do whatever they wanted and it's not like a high stakes testing environment. So if somebody doesn't do what they're supposed to do, it's really hard to tell unless you're in classrooms every day.

She acknowledged, "I'm not taking any of it personally."

Mill remarked that she never would have taken her position if she fully understood the culture she would face and the other specialist was looking for a new position in a different school. These two second-time specialists had visions and ideas that may have been implemented more easily previously; these ideas were met with skepticism and old ways of doing things. The experiences of these two second-time specialists were described in previous sections as well, and their feelings toward their school culture stood in stark contrast to the experiences of those who had former roles before transitioning into a math specialist role.

Unlike Mill and Hillary, Sherrise had a more successful time transitioning; she had held a former position as a math specialist out-of-state. Her career trajectory was unique in that she transitioned from teacher to coach to administrator and decided to come back into teaching and coaching. She was not facing the same kind of pushback as Mill and Hillary had experienced and was appreciative of the school culture. She spoke

of the difficulties she faced in her former roles in charter schools and administration and she preferred working as a math coach. Sherrise differed from Mill and Hillary in that she did not speak favorably of her previous position whereas Mill and Hillary did. However, her story demonstrates that one can be successful as a second-time math specialist.

Self-perception as a challenge. Transitioning to a math specialist position involved changes in professional relationships as well as changes with one's own professional identity. Specialists learned to take on a pseudo-administrative role, which was added to or replaced their former teaching obligations, especially if they transitioned from teaching positions, as they continually self-reflected upon and self-assessed their performance and identities. As math specialists added on instructional leadership duties in addition to teaching (or in place of teaching), they learned to manage a new self-identity as a professional. Some math specialists did not view themselves as leaders, even though they were making a systemic impact, whereas others viewed themselves as leaders at their school sites. This contrast is discussed further in the following section.

Ranking leadership last. Learning to take on additional administrative responsibilities (in addition to or in lieu of teaching) without the formal title of an administrator required math specialists to learn how to manage their own professional identity in relation to the teachers with whom they work. When asked to rank their strengths in mathematics content, pedagogy, leadership, and relationship building, eight out of 16 ranked leadership last (Natalie, Elise, Orena, Ted, John, Mill, Jenny, and Deidre) and three ranked leadership second to last (Laurie, Vicky, and Sherrise). The respondents represented a very mixed group in terms of years of experience in education and formal training in their roles. Natalie stated, "I don't see myself as a leader." Even

Jenny, who holds the formal title of a Lower School Director of Math Curriculum, ranked leadership last.

Others ranked leadership low for different reasons related to the limitations placed on their positions. Ted, who had worked as an administrator prior to assuming his position, stated that the support he provided to teachers has allowed them to become more autonomous with mathematics instruction and he was less needed in this regard. Therefore, he was comfortable in ranking leadership last. A unique example was Laurie, a veteran educator, who worked with another mathematics specialist at her school. When she first started as a math specialist, she had greater coaching responsibilities, but later she realized that she wanted to focus on her teaching and requested less coaching responsibilities. Limiting her leadership role was something she had chosen for herself.

Specialists mentioned that they saw themselves as supportive figures to their colleagues rather than leaders in their coaching role. Elise stated, "My leadership comes from more of I'm here to support you, I want to help you." Vicky also mentioned that her approach to teachers was to ask, "How can I serve you? What do you need?". Natalie stated,

> I don't display as an expert in any means. I'm just someone who loves teaching math and loves this math curriculum, and I want to help teachers and try to help the students in any way I can. So, I am not giving this top-down authority of, "I am an expert and you must listen to me."

Learning to manage their own self-perceptions as coaches and whether or not they consider themselves leaders was something mathematics specialists wrestled with as they transitioned into their roles. Many specialists did not consider themselves to be leaders

with respect to their own definitions of leadership. However, when challenged to think about why she was promoted to her position, Jenny stated,

> Sometimes I feel I'm very hard on myself…like I'm not making the positive impact I want it to be… But I think maybe people saw me as a leader or the administration did to put me in this position. But I guess if I just think about myself personally, I think that's an area I could grow, but maybe I do a good job of faking it.

Deidre stated, "When I get the chance to [lead], I do a decent job."

Challenges of managing self-perception as a leader. These math specialists had to learn how to manage their own self-perceptions in relation to their new roles. Two math specialists, Rebekah and Kathy, stated that leadership was their top strength and three specialists (Landon, Hillary, and Kitty) ranked it as their second strength. These five specialists had a range of previous experiences in education as well as training.

Landon applied for a math specialist position because he was interested in eventually entering into administration; he saw this position as an intermediate step into administration. Understanding that his role held many administrative responsibilities, he asked for a change in his title to Lower School Math Coordinator, although his responsibilities were similar to when he held his previous title. He had responsibilities that were exactly the same as when his official title was "math specialist." He elaborated further and mentioned that "specialist" is synonymous with teacher at his school, stating "There's all these administrative pieces to my role…my title shouldn't match that of someone with a different role." He viewed himself as a leader. Furthermore, Rebekah, the

specialist who organized the Mathematics Consortium and was attending professional development for leadership, believed that her strongest attribute is leadership.

Some specialists believed that they have the qualities of being a leader, but felt stifled by the limitations of their role. Mill and Hillary were used to being instructional leaders who held greater leadership abilities; they were used to having more clout in their previous schools. As mentioned previously, although Hillary was able to observe teachers at-will at the beginning of the year, this was prohibited later on because it made teachers uncomfortable and she was asked only to speak with teachers about math instruction, not other content areas in which she holds expertise. They both wanted more leadership responsibilities and had ideas that were not being implemented. For instance, Mill wanted to lead parent sessions; he had brought this up to administrators and was rejected. Furthermore, although John held a doctorate in educational leadership and was familiar with theories on how to be a strategic leader, this was his first year and his role is closer to that of a math teacher than a coach. In this regard, math specialists were limited by their administrators. Finally, Kitty, a part-time specialist with no prior experience teaching, considered herself to be a strong leader because she has worked in various leadership positions in her previous corporate career, although her position mirrors that of a teacher.

Overall, math specialists had to learn how to manage their new roles and identities. There was a wide range of specialists, from those one who was letting go of her leadership responsibilities to focus on teaching to those who saw themselves as supportive figures to those who view themselves as leaders within their school community.

Learning to manage friction. Specialists adopted a spectrum of approaches when teachers were not receptive to their ideas. For example, one specialist would "call teachers out" for their behavior and reiterated that respect and important another allowed teachers to ignore her email communications and worried she might be too much of a "push-over." (The latter professional mentioned that she had not made many significant changes since taking on her role from her predecessor, even though she had held the position for 2 years.)

Specialists mentioned that they focused on "baby steps" and "small wins" to build relationships with teachers who were resistant to their influence. Some mentioned that they brought these instances up to administrators who either advised them or would intervene. It may be that this tension needed to be negotiated in order for a math specialist to make an impact and change teaching practices at their school. Being a "pushover" and allowing resistant behavior to persist without taking steps toward change may not be the most effective strategy. Also, pushing for too much change in the beginning may also burn professional bridges and prevent future progress. Math specialists walked a fine line between building trust and relationships with teachers while at the same time expanding their influence and leadership to create instructional change.

Advice Math Specialists Would Give to New Specialists

Math specialists were asked what advice they would give to a new math specialist, either at their own school or at a different school. The most common themes were to understand the needs of the teachers and school (which was mentioned by eight out of 6 specialists), try to learn and not try to make significant changes too quickly (eight), and build relationships with teachers (eight). Vicky advised, "be of service to

teachers" and, stated by Elise stated, "[It] takes time for teachers to welcome you…keep coming around…they will come to your side." Five specialists also mentioned receiving support from administrators and building upon relationships with administrators. Six stated that a specialist must thoroughly understand mathematics content and pedagogy in their role.

Table 3

Advice Math Specialists Would Give to New Specialists

	Understand responsibilities	Understand needs of teachers and school	Understand school culture	Learn first and do not make changes quickly	Build relationships with teachers	Build supportive relationships with admin	Know content and pedagogy	Know how to use data	Negotiate salary
Rebekah	x	x			x				x
Natalie		x							
Elise					x		x		
Landon				x					
Orena							x		
Ted	x	x			x	x			
John		x			x				
Mill		x		x	x		x	x	
Hillary	x		x	x		x	x		
Laurie				x			x		
Vicky		x		x	x				
Kathy					x	x			
Kitty			x	x		x			
Sherrise		x		x		x			
Jenny		x			x				
Deidre				x			x		
Total	3	8	2	8	8	5	6	1	1

Table 4

Math Specialists' Career Information

	Years Working in Education	Years as a Specialist at Current School	Full-time or Part-time	Math Specialist at Current Site	Previous Experience at Current School
Laurie	25	6	FT	2nd	Teacher
Kathy	24	3	PT	1st	Teacher
Ted	19	5	FT	1st	Teacher
Deidre	17	7	FT	3rd	Teacher
Elise	13	3	PT	1st	Teacher
Natalie	13	3	PT	1st	Teacher
Rebekah	13	3	FT	2nd	Teacher
Jenny	7	2	FT	3rd	Teacher
Orena	1	1	FT	2nd	Parent
John	18	1	FT	1st	
Mill	16	3	FT	2nd	
Vicky	15	3	FT	1st	
Hillary	15	1	FT	2nd	
Landon	12	3	FT	2nd	
Sherrise	10	2	FT	3rd	
Kitty	1	1	PT	2nd	

Out of the eight specialists who advised that one should focus on learning before tying to make changes too quickly, six specialists were completely new to their workplace and had not been familiar with the school as either an employee or parent. Only one specialist, Rebekah, stated that math specialists need to negotiate salary because they take on additional roles to being a teacher.

Conclusion. Overall, all math specialists faced challenges in their positions and had to learn how to manage tensions with teachers and administrators. Those who had prior relationships with their schools spoke of positive relationships and school culture, whereas those who entered their roles without prior experience advised that the first thing new specialists should do is learn and absorb. The challenges math specialists faced would also direct the kinds of learning they would need in order to carry out their roles.

In this manner, there was an intersecting relationship between their challenges and learning.

Learning

Mathematics specialists provided mathematics instructional support and leadership and continued to learn throughout their tenure. Specialists continued to build upon their content and pedagogical knowledge as they worked with new grade levels and curriculum.

Mathematics content and pedagogy: Pedagogy and perception. When asked to rank their skills (out of content, pedagogy, leadership, and relationship-building), nine specialists ranked pedagogy as either their first or second strongest skill, with five ranking it as the top skill and four as their second. Knowing mathematics content and how to teach it best was a skill that specialists continued to hone throughout their tenure.

Specialists showed me instructional tools that allowed students to learn math in a hands-on manner, including tangrams, dice, a deck of cards, a math game, and Cuisenaire Rods. One showed me a roll of toilet paper and explained that she was creative and would use everyday objects to encourage mathematical thinking. She explained to me the various mathematics students could do with a roll of toilet paper, including finding the surface area, which provided a more authentic experience than when math is done with only paper and pencil. Another showed me his sunglasses. He learned that when his nephew seemed bored or unruly, he could put on his sunglasses, use an entertaining voice, and take on a character named “Mr. Cool” to calm as well as interest him. He took this character, which was a result of learning from his personal life, to the classroom and

used it to teach math to his young students entertainingly. In these ways, math specialists continued to develop their pedagogical skills to meet their students' needs.

Professional development and learning opportunities. Math specialists in this study sought out professional development opportunities that were funded by their schools. Most specialists (with the exception of Natalie, Orena, and Kitty) mentioned researching conferences and professional development sessions and attending them to improve upon their practice.

Laurie stated that her school has "been very supportive and [she is] given permission, upon request, to attend professional development in math." Landon stated that his "school expects you to have ongoing professional development and then you set goals at the beginning of the year and your professional development should be based off of those." Since his role entailed working with instructional data, he attended the ERB conference this past year. Commonly mentioned sessions included Jo Boaler's conference at Stanford University, Greg Tang's math conference, as well as the national ERB conference and NCTM conference. John spoke of "mak[ing] observations about what kind of PD would best serve [his] campus and [his] teacher population" and Rebekah had brought in trainers to train the entire teaching staff.

Specialists brought artifacts that represented their learning. Orena and Mill showed me books published by Jo Boaler. They described to me how these books encouraged them to think about teaching mathematics in an experiential manner and the importance of students' mathematics mindset. They told me that they both attended Jo Boaler's conference at Stanford and mentioned that she has a Facebook page where she posts updates and new ideas for teaching mathematics. Another specialist showed me a

book called *Beyond Pizzas and Pies,* which helped her to think about teaching math in unconventional ways. Rebekah showed me something called a "golden circle," which she worked on in her Women Rising processional development, depicting a reflection on her purpose as an educator. This particular conference was unique because it was intended to build her leadership abilities whereas all the other professional development opportunities mentioned focused on mathematics pedagogy and content. Overall, these collections of professional development resources showed how math specialists were continual learners in their profession.

Although most specialists were able to request attendance at conferences and professional development opportunities that are funded by their schools, there were a few exceptions. The three specialists who were not able to attend conferences at this point included Orena and Kitty, the specialists with the least prior experience in education. Orena completed an online PD at the beginning of the year, but has not requested any additional PD because she is "trying to keep afloat with lessons" and the responsibilities of being a first-year educator. (She even had a mentor teacher who was teaching her necessary skills like classroom management.) Also, Natalie and could not apply for funding for professional development because they worked part-time.

Learning opportunity: "Mathematics consortium." Rebekah had utilized professional development opportunities intentionally and aggressively to further her own learning and the learning of her colleagues. In addition to mathematics professional development opportunities, she participated in a program called Women Rising, which focused on fostering the leadership abilities of women in education. Furthermore, she created a group called the Mathematics Consortium during her first year as a math

specialist. She took the initiative to reach out to all elementary mathematics specialists she knew of and invited them to her school. She led a discussion on mathematics instruction covering various topics like differentiation. From then on, other math specialists began to take the lead to host meetings and a supportive email group formed. Specialists could ask each other questions regarding curriculum use and supplements, professional development, and various other topics. Twelve of the 16 participants had been involved with this group in some capacity and found it to be a helpful resource. Jenny stated,

> It's been really amazing to have that group… we're all going through the same thing where our jobs are a little different… We have ways we want our jobs to grow and shift. It's really nice to have that community to ask these questions to. But it's not like there's anybody else I could ask at my school that can answer these questions.

The Mathematics Consortium, a unique group created by Rebekah in the Los Angeles region, allowed math specialists to connect with each other through meetings and email communication. Elise stated,

> I think that being in this role, it's very lonely and you're the only person on campus who's doing what you're doing… Because [we] don't even have a literacy coach, I don't have someone who's even doing the same sort of thing but with Language [Arts]. So what I have found is being able to go to this math consortium of other math coaches is getting ideas, seeing what's working at their school, what's not working at their school. We now have an email chain where we're constantly emailing each other. It's just like, it's almost like being at a

> conference all the time, because you're constantly getting a wealth of information.. It's been fantastic.

Learning from other teachers. When educators transition into math specialist positions, they have experience teaching math that is limited to certain grade levels with which they have worked previously. This meant that specialists took on leadership positions in grade levels that they had never taught and were unfamiliar with the specific mathematics content, standards, curriculum, and students of these grade levels. Landon, who had previously worked with fourth and fifth graders, stated,

> The hardest part was resetting expectations because when you work with little kids, you can't push them as fast as you can older kids and they're not as independent. I think that was the biggest adjustment more than anything, it's probably pedagogy with the younger students.

Natalie was experienced in working with students in fourth grade and older and had to learn how to work with lower grade students through observing other teachers. Jenny echoed this sentiment, sharing that she was completely new to kindergarten and had to speak with the teachers in order to "learn how to talk to [kindergarteners]." This was a common experience among specialists in that they learned how to work with unfamiliar grade levels from their colleagues. Elise stated that her greatest learning curve was:

> definitely preschool. I have no experience teaching that age group and our school starts at 2 years, 9 months. So, I spent time just sort of talking to the preschool teachers and what actually was expected from a child before preschool, and then how we can weave that in.

Ted stated, “What’s cool about being a math specialist, is I can observe a lot of different people teaching, even one-on-one or in groups, and so I’ve become a better educator, because I’ve been able to see a lot more.” Orena, a first-year educator, commented,

> I was assigned a mentor [who is a] third grade teacher. And she has been just invaluable at giving me ideas. Not so much for how to teach a particular concept but for classroom management and like little things that will make my classroom and teaching run more smoothly. She came and observed when I was really struggling with some classroom management, she came observed and gave me feedback, like direct feedback on what she saw.”

Exposure to teachers of different grade levels through observations and professional interactions provided learning opportunities for specialists. Although mathematics specialists may have been hired to coach teachers in mathematics instruction, they continued to develop their skills by learning from the teachers they were hired to coach.

Independent learning. There were other ways in which mathematics specialists sought to improve their practice. Although Orena did not attend conferences, she requested an NCTM website login to access resources. John used Twitter to follow math coaches and instructional leaders. Mill also mentioned how she joined a Facebook group run by Jo Boaler where she was able to gain ideas for mathematics instruction. In this manner, specialists were able to conduct independent research online to further their learning.

Additionally, in the artifact analysis, two math specialists, Ted and John, showed yearly journals they keep for the purposes of teaching math and in which they reflected on mathematics teaching strategies that worked and failed. John commented,

> I'm notorious for doing that, for going back with my journal and looking and thinking and counting time out of my day… to kind of reflect what really worked well, what didn't work well… Who was getting it? Who was not? How can I meet them where they're at?

Ted stated,

> I've been in education for 18 years, so i look back to some of my older journals and see some of the things I used to have to deal with, with parents or students, and it helps me to kind of keep track of where I've been and where I'm going, and to reflect on what things I did well, and how I can improve my teaching.

Overall, mathematics specialists sought out different ways to continue their development as educators. The following section examines how math specialists learned to manage and build relationships.

Relationships and Negotiations

Participants also navigated relationship challenges, forged support networks, and negotiated for themselves as well as their vision.

Building relationships with teachers.

Leading with a non-evaluative role. All of the mathematics specialists had to develop professional relationships with teachers. As Kathy stated,

> The challenging part is being the middle person... between the staff, between my teachers and the admin...my role is kind of like an administrator... [but] I'm not an

> administrator. I don't want to be an administrator, but I'm kind of like above the teachers. It's hard to explain, but it's having their support and having their respect.

Mill stated, "I'm not an administrator, they don't report to me, I don't evaluate their teaching but they sometimes find it intimidating so it's a thin line just to come in and watch somebody." Math specialists could be placed in tricky positions where they were hired to help improve teaching practices of their colleagues but held no evaluative responsibilities. However, this lack of authority could be both stifling as well as beneficial to the teacher-specialist relationship.

Ted stated that the teachers:

> know I'm not an administrator, so if they have an issue with math, like the way that they teach it, they can always come to me and I can be frank with them, or give them suggestions, and I love that it's non-threatening. They don't feel threatened because I'm never writing it down and submitting it to anybody.

Building trust with teachers was important because teachers needed to feel safe in sharing their teaching struggles with the math specialist. John stated that he would reflect and consider,

> How can I build trust with this person? How can I get them to kind of buy into my philosophy? [And he tried to] build authentic connections... trust and not hiding behind anything [and was able to ask them], "Why are you doing that?" and "Why do you think that's working?'"

He stated that "It can be a really difficult conversation to navigate, but...those are the types of conversations that I am looking to have with colleagues." Vicky echoed, "I really

found that I need to gain the teacher's trust...because a lot of times, as a coach or a specialist, we're asking teachers to try something new or something different."

Furthermore, Hillary shared a story about a particular teacher with whom she worked. She stated,

> The teachers that I interact with, they're not pedagogically sound. So I was working with a second grade teacher and she had a student that was subtracting 49 minus 37, and he took three from 49 and gave it to 37 and then didn't give the three back to the 49, right? The solution that he was getting was wrong and she couldn't understand why he was incorrect… And I have teachers that don't understand the actual math that they're teaching. So they don't have the content and then they're not quite sure how to scaffold.

When asked how she addressed these situations, she stated,

> I give feedback. I don't want to be put in a position where I have to evaluate. I don't think it's appropriate because that changes the trust dynamic as a coach. But I do give them feedback about it, and then there's a lot of ... it's like a dance. You can't come on too strong because then they'll sit down. Every teacher has their own unique personality, so you have to find a way to navigate ego.

Mill, a second time math specialist, stated,

> I was anxious to make some changes and to make an impact and I had to back away because it was turning people off before they had enough trust. So I learned that I had to do it much more slowly, that just by virtue of being hired for your expertise doesn't mean that people will respect and embrace that. And that was an eye opener for me.

Overall, while holding no authoritative or evaluative roles, mathematics specialists needed to learn how to build relationships with teachers to encourage them to try new pedagogical ideas to create instructional change in their schools.

***Credibility*.** In order to build relationships with teachers, math specialists needed to develop a sense of credibility and trust. John believed that having a doctorate helped him establish his credibility as a mathematics specialist. Vicky, who was working on finishing her doctorate degree, echoed this sentiment; however, she stated that having been a teacher held greater weight. Similarly, Rebekah believed that her involvement in teaching students—rather than being completely removed from the classroom—allowed her to build her credibility with teachers with whom she works side-by-side. She stated,

> I know in other schools, math specialist just coach teachers and are the resource for math curriculum, but they don't necessarily work with kids. I work with kids. That's an expectation and actually I really want that and like that, because I get a lot of credit from teachers as a coach when I'm in the classroom, working with the same kids, struggling through the same kids with them, alongside them… I can get my ideas across and they can be better received.

As stated previously, many specialists were new to the grade levels with which they worked and continued to learn throughout their tenure. Kitty, who had no previous full-time teaching background, was still able to build trust and credibility by being "honest and open." She stated, "I told them what I can and can't do... I don't believe in talking it up or creating a false identity. I believe in just actually action. [And I] showed them what I can do." Orena even had a mentor teacher who was helping her navigate her

first year in education. These specialists showed that being transparent about their own abilities and shortcomings could help them build relationships.

Strategies for dealing with challenging teachers. Mathematics specialists had to learn how to work with teachers who were not receptive to their ideas. When asked about challenging teachers, veteran teachers were mentioned frequently. Vicky stated that "it can be difficult when they're like, 'Look, I've got my routines down, I know what I'm doing.'" Specialists mentioned various challenges and approaches to working with these teachers who may not be open to working with them.

Letting things go. A common theme was that math specialists would provide teachers their space and freedom to continue with previous teaching practices when new ideas were not welcomed. Jenny mentioned that she was flexible with teachers, and there were even times when her communications would go ignored and she would let it go. She knew that her approach allowed her to be amenable toward teachers, but she was worried about how "people could walk all over [her]." Even Laurie, a veteran educator with 15 years at her current school, faced issues of teachers using her model lessons as prep time. She talked to teachers about participating in the classroom while she was leading and even mentioned it to her administrators. However, at this point, she stopped pursuing this matter any further. In another example, Mill was conducting observations during the first academic month of her employment and teachers found this new model to be intimidating. Administrators asked her to stop this practice and only enter classrooms when she was asked; however, she continued to support teachers in other ways.

Furthermore, when Rebekah first started as a math specialist, she worked with a "long serving veteran teacher who really despite saying that he was open to the change in

curriculum really, in practice, wasn't and couldn't move from what he had been teaching for over 2 decades." She would work with him and he would agree to try out new ideas and then he would not follow through. Since then, there were changes in personnel—both teaching staff and administrators—and this veteran teacher stopped working at her school. She stated that an administrator coached her through the experience and she learned that "just sometimes, people are the way they're going to be. And you can lead a horse to water to drink and we're doing the best we can." Natalie echoed Rebekah's experience and mentioned that teachers have never said to her, "No, I don't want to do that" and she has "never been explicitly told no, but [she has] gotten the sense that they might not take [her] advice." Natalie stated, "You can give them all the advice you want in terms of best practices, but it stops there...you have to keep going."

Other approaches to creating change. Others mentioned creative, unique ways to support teachers who were resistant to their ideas. For instance, John worked with a veteran teacher who was uncomfortable inputting data into spreadsheets. Instead of turning a blind eye toward this issue, he worked with the teacher's assistant who was more comfortable using technology to input data; in this manner, he was able to obtain the student data he needed.

John mentioned that, at times, he needed to get the support of administration in order to obtain the teachers' cooperation. Furthermore, Kathy noticed that some people will not pay attention during her meetings and will use their cell phones or laptops. To address this, she designed interactive activities in which teachers could participate. Sometimes, she would even "call them out" for disrespectful behavior. Landon worked with a teacher who, in his opinion, was "being more or less lazy with their math

instruction" and would not adequately prepare to the point that the teacher did not know what lesson she was teaching. Instead of expressing his frustration in the grade level meetings, he set up a time with her to speak with her in private.

Furthermore, Deidre would make suggestions for teaching and schedule follow-up meetings with the teachers; she did this to establish accountability for the teachers. (She felt that she had to do this particularly because administration didn't review teachers.) Furthermore, Rebekah "sold" her ideas to teachers and talked to them individually. Similarly, Sherrise worked with one teacher who was "fairly rigid… and gets pretty defensive easily." When asked how she managed this situation, Sherrise stated that she continued to find research and presented new ideas to her and "sometimes she's open to it, sometimes she's not." "I just go back again to the struggle with students," she stated.

Time to build relationships. Math specialists built relationships with teachers over time, which allowed them to become more effective at influencing teachers. Elise stated,

> It definitely took a year… People—I think—thought I was going to be telling the head of school that their classroom was horrible and they didn't want to let me in. And then a little bit at a time as they saw that I was bringing them things or I just wanted to help them out, the doors started opening. So, I can say that this year, in my third year, it's drastically different than it was my first year, for sure.

Mill also stated that "the teachers have come around to be receptive to many of my ideas. As an institution, we're not quite making the changes yet. One person at a time."

Math specialists practiced flexibility in managing wins and losses with teachers. As Hillary put it, "It's like a dance. You can't come on too strong because then they'll

shut down. every teacher has their own unique personality, so you have to find a way to navigate." Specialists had mixed accounts of teachers who were supportive of them and those who were resistant, and all specialists were able to share stories of managing resistant teachers. Specialists persevered through pushing back, making small wins, and beginning to build trust, credibility, and relationships over time.

Relationships with administrators.

Support. Math specialists needed to learn how to work with administrators and build supportive relationships. When I asked specialists about a person who may have been professionally supportive, all participants mentioned at least one administrator. Administrators helped these specialists by providing mentorship and advice on how to approach certain teachers and by approving attendance at professional development opportunities. Although most administrators did not have a background in mathematics teaching and were unable to support specialists with mathematics instructional decisions, they were able to mentor specialists in managing relationships. Sherrise mentioned that there are "not a lot [of challenges and she is able to be] open even about challenges and relationships…. I feel pretty comfortable going to them and we work through a lot." Although all math specialists mentioned that their administrators had been supportive of them, they were also able to provide instances in which relationships with administrators were challenging.

Difficulties with administrators. A common frustration was that administrators did not fully understand the scope of the specialists' position. Natalie stated, "They never really check in on me… I don't think they really know what I do sometimes." Landon echoed this belief and mentioned that administrators do not know all that he does in his

role and were continuing to add to his professional responsibilities. He had to have a discussion with his administrator in which he explained that he was starting to have difficulties maintaining a healthy work-life balance given his workload. Ted expressed that he was frustrated when administration did not communicate clearly and would make vague statements like, "We want [you] to help every teacher," or ask him to "help new teachers" without giving specific requests.

Furthermore, another issue occurred when administrators provided excessive freedoms to teachers even if they were not complying with school decisions. Elise worked at a school where no formal observations of teachers were taking place. When she shared with administrators that teachers are not adequately prepared to teach lessons, nothing was done. Mill stated that the teachers "have complete autonomy, so there's no coordination and consistency and collaboration." Hillary mentioned that one of her administrators was personally supportive; however, the administrative team was unaware of how to use her expertise most effectively. As mentioned previously, she was prevented from entering into teachers' classes for observation without an invitation from them, something she was allowed to do at the beginning of the year. This decision was made without her input to accommodate teachers who were not accustomed or comfortable with someone observing their teaching without an appointment. Furthermore, although she had extensive experience working in administration, she was asked not to speak with teachers about literacy and content areas outside of mathematics. In this manner, her administration was allowing for cultural and relationship structures that would limit her role.

Overall, inadequate communication and a misunderstanding of the specialist's role and lack of follow-through with teachers were commonly mentioned challenges.

Relationships with parents. Math specialists had to learn how to interact with parents in different capacities, whether running parent sessions, participating in open houses or parent-teacher conferences, or holding meetings. The parent demographic of independent elementary schools is typically composed of upper-middle to upper class families who hold high expectations. Specialists mentioned that they had a mix of parents: some are supportive and others put too much pressure on their children and academics. Ted stated, "Some parents are really good about calming their kids down about standardized exams. Some have them go to special classes outside of school." John stated that, in his role, "There is a fair amount of psychological navigation." Regarding his parent population, he mused, "How do we build on small successes so that we can alleviate that anxiety?"

Most math specialists were able to provide examples of challenges they had faced with parents. However, John stated that his doctoral degree has helped to put parents at ease and enable him to gain their support from the start. According to him, he had not experienced much conflict with parents, and had witnessed mostly excitement about his joining the team. Mill also had substantial parent support, and they were happy that she created a pre-algebra program for the advanced students.

Others faced greater initial skepticism, such as Landon who had to meet with parents who did not know who he was and had issues with their math program or student placement. Landon and Laurie dealt with parents who disagreed with the placement of their child into a certain level and wanting to advance their child. A total of six specialists

mentioned parents who wanted acceleration of their child's mathematics education even though, according to Orena, there may have been a "disconnect between parents' thoughts on students' abilities and [their] true abilities." Vicky stated that working with parents was the "most challenging part of what [she did]" and that they are a "well-educated population and leaders in their profession… [and they] sometimes have philosophical disagreements about teaching, [with] some wanting more traditional teaching." A total of five math specialists mentioned that parents were uncomfortable with the curriculum because it did not reflect the traditional teachings they grew up with and they ran meetings and parent sessions to ease tensions, as mentioned previously.

Specialists needed to learn how to interact with their students' parents in order to foster trust in the mathematics teaching at their school. For instance, Rebekah had to explain to parents through hosting two yearly sessions to explain the benefits of teaching students with bar models and bonds, strategies parents with which are not familiar. She eventually "won over parents to Singapore Math."

Relationships with students. Even with the challenges that come with being a math specialist, a common thread among these professionals is that they loved seeing their students succeed. When asked about the best experience of being a math specialist, stories of students began to emerge. Specialists were able to see students' progress throughout the years. Ted beamed, "I've literally worked with them since the first grade until fifth grade. And so I get to see their progression every single year… it's been really great to see that. Laurie enjoyed seeing girls succeed in math and Vicky felt it "was a big success" to provide enrichment to high achieving students. Like several specialists, Jenny mentioned that she tried to "make math fun for students," and Deidre stated, "I feel like

when they have those aha moments in math where things finally click, and they feel so confident and so successful. I mean, that's incredibly rewarding."

Math specialists shared with me notes and birthday cards from students they had collected over the years. Others had pictures of students at their graduation. Even though the students may have graduated and left their classes, it was obvious that these students had a special place in these educators' hearts and inspired them to continue in their profession.

Roles and Responsibilities

The roles and responsibilities of math specialists varied depending on school needs; furthermore, specialists' duties and schedules changed throughout each academic year and over their tenure. Learning the purpose of getting hired as a mathematics specialist as well as their current roles helped shed light on how the position can evolve, if at all. Although the responses garnered were not directly intended to reveal what math specialists need to learn, knowing what specialists actually did offered information about what one may need to learn in order to be a math specialist.

Math specialists commonly mentioned four distinct responsibilities of their position: teaching students, supporting teachers with mathematics instruction and usage of curriculum, working with parents, and using data. Fourteen participants were involved in teaching students, 14 are involved with coaching teachers (12 of these 14 led professional development sessions for teachers), seven participants led sessions for their parent body, and 13 analyzed student data. This information is discussed further in the following sections.

Table 5

Roles and Responsibilities of Math Specialists

Pseudonym	Teaching Students	Meetings to Coach Teachers	Leading PD for Teachers	Leading Parent Sessions	Analyzing Data
Rebekah	Yes	Yes	Yes	Yes	Yes
Natalie	Yes	Yes	Yes	Yes	No
Elise	Yes	Yes	Yes	Yes	Yes
Landon	Yes	Yes	Yes	Yes	Yes
Jenny	Yes	Yes	Yes	Yes	Yes
Ted	Yes	Yes	Yes	No	Yes
Hillary	Yes	Yes	Yes	No	Yes
Kathy	No	Yes	Yes	Yes	Yes
Sherrise	Yes	Yes	Yes	No	No
Deidre	Yes	Yes	Yes	No	Yes
Vicky	No	Yes	Yes	Yes	Yes
Laurie	Yes	Yes	Yes	No	Yes
John	Yes	Yes	No	No	Yes
Mill	Yes	Yes	No	No	Yes
Orena	Yes	No	No	No	Yes
Kitty	Yes	No	No	No	No
Total	14	14	12	7	13

Teaching students. Most of the specialists (14) held teaching responsibilities within their schools. Some had set classes that they taught daily and others had flexible teaching schedules based on the needs of students and teachers. Mill stated that there is "no typical day," and her day-to-day schedule varied throughout the year. She pre-assessed students for regrouping every unit; taught flexible groups of fourth, fifth, and sixth graders; and worked with students who needed enrichment and extra support in small groups. Her involvement with students was constantly changing throughout the year. This seemed to be a common experience for mathematics specialists.

Out of the 14 specialists who taught, only six were aware of their teaching responsibilities upon hire. Landon, a Lower School Math Coordinator, mentioned that he

was surprised at how much teaching was involved in his position and thought his position would be more administrative. However, he was involved in deciding the students with whom he worked for enrichment and he increased his class sizes because that was how the data fell. In so doing, he was creating and increasing his own teaching responsibilities.

The two mathematics specialists with the least experience had limited responsibilities and their roles consisting mainly of teaching students. Orena did not have her own classroom and supported teachers in a push-in or pull-out model. She attended meetings where she shared her ideas, but her primary role focused on teaching students. Kitty also taught third through fifth grade math part-time and met with teachers to plan curriculum and to ensure alignment; her role seemed to be limited to the classroom.

Two specialists had very few teaching responsibilities. Kathy, the part-time second through 12th grade math coach, did not teach students. The only time this happened was when she would model lessons for teachers. Additionally, Vicky's role was intended to be a coaching position aimed at systemic improvement of mathematics instruction. Her direct involvement with students was limited to modeling lessons, assessing students who may have gaps in their knowledge, and subbing for absent teachers.

Coaching teachers and leading professional development. All but two of the specialists had coaching roles embedded into their schedules, either through leading professional development sessions or via meetings with teachers. For example, Landon met with teachers once a week and Jenny led professional development sessions for teachers. Rebekah stated,

> I try to stay ahead of the teachers. So I'll give them sniper presentations, notes on lessons and units, heads up on assessments. I'll plan all the assessments for them. We'll talk about how to go over the results for the assessments, next action steps… So I do planning. I also then will sometimes meet with teams, maybe about once a month [to talk about struggling students and designing intervention groups].

Out of the 14 specialists who coached teachers, 12 also led professional development sessions.

Five specialists (Rebekah, Hillary, Vicky, Kathy, and Sherrise) mentioned modeling lessons for teachers. When Vicky started her position, she used to observe teachers and provide feedback; however, administrators told her to do this only when asked to by a teacher. She did not agree with this decision; however, she still assessed students (identified by their teachers as struggling or advanced students), provided teachers with resources tailored to these students, and conducted model lessons.

Although Kitty and Orena did not hold formal roles in leading professional development sessions or observing lessons, they were involved in grade level meetings in which they shared their ideas of mathematics teaching. These specialists were also the least experienced in working in education prior to entering into their roles; Vicky was a first-year educator and Kitty was a part-time math specialist who had only volunteer teaching as a prior experience in education.

Furthermore, Laurie used to have a greater coaching role; however, she had requested less time working with teachers to focus on teaching students. She was a veteran educator with 25 years of experience, and although she still did work with

teachers one-on-one, it was to a lesser extent than when she first started as a math specialist. There was a greater need for teacher support when she first started, but she was in her sixth year in the position and with another math specialist working with her at her school, she was able to relinquish her some of her coaching responsibilities. This was an exceptional case, with a greater number of specialists who entered into the position to increase their involvement in leadership, which is discussed in later sections.

Overall, 14 specialists (with the exception of the two least-experienced educators) held formal responsibilities of coaching teachers. Out of these 14, eight were informed that they would coach teachers when they were hired. All mathematics specialists held a role in working with teachers, whether it was through a formal coaching model imbedded into their schedule or informally as colleagues. The extent to which they were involved in working with teachers changed throughout their tenure as well as throughout the school year.

Using data to improve instruction. Although only one specialist, Hillary, was informed upon hiring that a goal for her position was to improve students' performance on standardized exams, many specialists worked with student data in various ways. Overall, 13 out of 16 specialists mentioned using testing and ERB data to track student performance as well as to create intervention and enrichment groups for differentiated instruction.

ERB exams. The ERB exams are standardized exams that include mathematics and language arts sections. Independent middle schools consider fifth grade student scores in their admissions process. Because of their weight in middle school admissions, Vicky stated that the ERB scores become "super, super important." Hillary and Ted both

had administrators who stressed student performance on the mathematics section of the ERB exams and Vicky and Elise mentioned that middle schools required submission of these scores during the application process. Elise stated,

> Weeks before we take the ERBs, I have [teachers] start prepping [students] in terms of just what it's going to look like, let's review some vocabulary, let's understand if you're doing a quantitative reasoning test, what it looks like" and mentioned "parents do know that the ERB scores are submitted to these [middle] schools that they're applying to… [they] put a lot of pressure on their kids to do well.

Landon "went to the ERB conference…to learn more about the ERB and to help [him] do a little bit more data analysis."

In fact, many specialists used and analyzed ERB scores in different capacities. Deidre, Laurie, Mill, and John analyzed ERB scores to determine student grouping and Elise had noticed that her student scores have been rising. Kathy helped lead meetings with parents to discuss students' ERB data, especially in situations where the teachers were nervous about these discussions. Jenny was concerned about an aberration in her student data and has brought this up to other math specialists to solicit ideas for improvement. In this manner, math specialists were in charge of keeping track of changes and trends in ERB student performance data, used data (including other factors including teacher recommendations) to design a method of grouping students, and to find ways to supplement their curriculum when there are dips in scores.

It is noteworthy that math specialists worked with data, especially ERB data, and spoke of the pressures around students' performance on this standardized test. This was a

change from what they were informed initially upon hire, especially given that only one person was initially informed of testing pressures.

Students' assessment scores. In addition to analyzing ERB data, math specialists also kept track of students' test scores on unit exams. John used the beginning of the year assessments, grades, mid-year assessments, ERB scores, and teacher recommendations to create enrichment groups. Mill also used assessment scores to identify students who needed extra help and created four groups of leveled classes. Elise stated, "I do a lot of data driven work in terms of tracking the classes…kids take benchmark tests at the beginning, middle, and end of the year. And I track where they are." Even Orena, a first year educator, used pre-tests scores to gauge students' prior understanding. Overall, math specialists used assessment data to create groups of students for intervention and enrichment as well as to gauge student understanding.

In addition to using data, specialists worked with the parent body, which is discussed in the following section.

Managing and working with parents. The parents of students at independent schools throughout the Los Angeles region can be very demanding and hold high expectations for mathematics teaching. Hillary described her parent body as the "echelon of Hollywood" and Rebekah, Hillary and Kathy described their parent body as "wealthy." Landon stated that although the:

> population is not as wealthy [as some of the other independent schools], [their] parents are highly educated…. They've researched math programs… so they often know what they're talking about, or at least minimally… and therefore can come on pretty strong with what they want.

Laurie spoke of parents who wanted their students in higher level math groups than their current placement. Participants reported having varying degrees of professional interaction with the parent body, which is discussed in further detail.

As discussed previously, Rebekah and Natalie were the only two math specialists who were informed that their position would entail managing parent relationships. In order to ease parent tensions, Rebekah led two parent sessions each year to help familiarize them with their Singapore Math curriculum. To a lesser extent, Nathan and Vicky have also led parent sessions. Although some specialists did not run parent sessions, they did have involvement with parents. Most specialists, like Kathy and Jenny, worked with parents when they requested a meeting regarding their student performance and were involved in typical whole-school activities like participating in open house.

The extent to which specialists interacted with parents varied between specialists and changed throughout the years. Landon spoke of having to interact with parents less (in comparison to when he was first hired) because they trusted him more, and Vicky and John wanted to design parent sessions in the future. Interacting with parents and even teaching them could be a required part of a math specialist role, one that may not be made clear to specialists when they are hired.

Specialists with unique roles. Two specialists held unique roles in comparison to their counterparts. Hillary worked as a math instructional coach and also taught science, which she estimated to be around 45% of her role. I considered excluding her interview for the purposes of my study; however, she was significantly involved in her mathematics department and was the only one carrying out this role within her school. Although her administrators seemed to be limiting her coaching role, she had made significant changes

to mathematics instruction; she had chosen a new mathematics curriculum, designed a gradual grade-by-grade implementation, and coached teachers, and she had only been at her current role for only a year.

In another extreme case, I also reconsidered whether or not Kathy was an appropriate participant due to her involvement with the secondary mathematics department; she worked with second through 12th grades. Similar to Hillary, Kathy had extensive experience in education and had previously taught and coached elementary mathematics. She was also the only one coaching elementary math teachers in her building. I decided her perspective was a unique and invaluable addition because, although she did not necessarily want to be an elementary math specialist, her school viewed her professional involvement as important.

Furthermore, I considered removing Kitty and Orena from this study due to their limited instructional coaching roles, with their positions mirroring the role of a teacher rather than a coach. However, this may have been due to their limited experience in education. Their involvement portrayed the experiences of relatively new mathematics specialists who enter into this position without much prior experience in education.

Overall, math specialists held different roles in differing capacities, which included teaching students, coaching teachers, and working with parents. Their roles would also change as they negotiated with school culture and relationships.

Changes in roles. Specialists' roles changed from their initial purposes of hire. Mill stated that she was provided a written job description that stated that she would "consult, teach, and support instruction" and she continued that "[They] probably pulled that off of a website somewhere because that wasn't necessarily how my predecessor was

operating but those were my expectations for my role." Table 6 compares the reasons for hiring with the actual roles of math specialists.

Table 6 provides a side-by-side comparison of the reasons for hiring provided to math specialists juxtaposed with their actual hiring. Of the four specialists who created their own roles, three were the first math specialists at their schools. Laurie, who requested her role, became the second math specialist at her school and is the only one with two specialists employed at the same time. Of the eight specialists who had held teaching positions previous to their promotion, only three (Elise, Ted, and Rebekah) were informed that they were hired to support teachers with a curriculum change and five (Natalie, Ted, Rebekah, Deidre, and Jenny) were informed that they were hired to support teachers with instruction. However, all eight specialists took on roles leading professional development and meetings to coach teachers.

In all categories including working with teachers, teaching students, managing parent relationships, and using data, specialists were not fully informed of what their duties would entail. Seven specialists were hired to teach students; however, 14 held roles teaching math to small groups of elementary students. Although only two specialists (Elise and Rebekah) were hired to manage parent relationships, seven had a significant role in doing so, and whereas only Hillary knew she would use data, 13 specialists analyzed data.

Table 6

Comparison of Reasons for Hire with Actual Roles

	Previous Experience at Current School	Reason for Hire: Created Own Role	Reason for Hire: Following Trend of Having MS	Reason for Hire: Replacing Former Math Specialist	Math Specialist at Current Site	Reason for Hire: Support Teachers with Curriculum Change	Reason for Hire: Support Teachers with Instruction/ Curriculum	Role: Meetings to Coach Teachers	Role: Leading PD for Teachers	Reason for Hire: Teach Small Groups of Students	Role: Teaching Students	Reason for Hire: Manage Parent Relationships	Role: Leading Parent Sessions	Reason for Hire: Improve Student Scores	Role: Analyzing Data
Elise	Teacher	x			1st	x		Yes	Yes		Yes	x	Yes		Yes
Kathy	Teacher	x	x		1st			Yes	Yes				Yes		Yes
Natalie	Teacher	x			1st		x	Yes	Yes		Yes		Yes		
Ted	Teacher				1st	x	x	Yes	Yes		Yes				Yes
Laurie	Teacher	x			2nd			Yes	Yes	x	Yes				Yes
Rebekah	Teacher			x	2nd	x	x	Yes	Yes	x	Yes	x	Yes		Yes
Deidre	Teacher			x	3rd		x	Yes	Yes	x	Yes				Yes
Jenny	Teacher			x	3rd		x	Yes	Yes		Yes		Yes		Yes
Orena	Parent			x	2nd						Yes				Yes
Hillary				x	2nd	x		Yes	Yes	x	Yes			x	Yes
John			x		1st			Yes		x	Yes				Yes
Kitty				x	2nd					x	Yes				
Landon				x	2nd	x		Yes	Yes	x	Yes		Yes		Yes
Mill				x	2nd		x	Yes			Yes				Yes
Sherrise				x	3rd	x	x	Yes	Yes		Yes				
Vicky					1st		x	Yes	Yes				Yes		Yes
Total	8T,1P	4	2	9		6	8	14	12	7	14	2	7	1	13

Math specialists needed to manage changes in their roles, including the capacity in which they coach teachers, teach students, and interact with parents. Specialists mentioned how their involvement within their schools had increased and expanded throughout the years in terms of teaching students, coaching teachers, and working with parents. This ranged from specialists having no formal responsibilities coaching teachers to those who were completely out of the classroom and were full-time coaches for teachers; from specialists who spend a majority of their time teaching students to those who do not work with students at all; and from specialists who run multiple parent sessions to those who have fewer interactions with the parent body.

Landon stated that his role had "morphed into more because I was capable… and there was just different holes and things that [he] had seen that needed to be filled." He took on more administrative responsibilities as well as grouping students and enlarging his class sizes. He stated, "The role has grown quite… I created more work for myself." Several math specialists spoke of finding a need in their school and addressing it. Laurie created math clubs that were so popular that she started to organize and host math tournaments on her campus. She stated, "Math clubs are a big part of why I'm proud of my position." Mill noticed that her advanced students needed a greater challenge and created a pre-algebra course for her sixth graders. In these ways, math specialists took part in creating and adding to their own roles.

A key reason for the disconnect between what the specialists' roles were intended to be and their actual duties was the fact that specialists learn, build relationships, and negotiate for themselves and their vision. These changes were not necessarily passive;

specialists had a hand in how their positions evolve. The next section describes this process.

Conclusion

Math specialists learned to make an impact within their mathematics departments, whether those changes are small or significant. When asked what their greatest success has been in their role, mathematics specialists referenced moments teaching students and creating programs for them, influencing teachers' instructional practices, and convincing parents how their teaching methods are effective through student mastery. No one mentioned an interaction with an administrator as his/her greatest accomplishment, but instead all participants rather focused on the other three relationships.

Furthermore, Orena, a first-year specialist whose role resembles that of a first-year teacher, was already contributing her ideas and sharing her projects with teachers. Additionally, although second-time specialists Hillary and Mill felt frustrated because they held more clout in their former roles, they have also made an impact. In fact, Hillary chose a new curriculum and was trying to implement flexible groupings for mathematics teaching, and Mill created a pre-algebra course and was supporting teachers with finding resources. Both spoke of wanting to leave their positions, but they have already made a mark within their schools.

Overall, the findings showed that math specialists all faced difficulties and friction in different capacities, and would have to continue to learn and evolve in their roles. Mathematics specialists were hired for commonly shared reasons (such as needing to replace a former specialist, having to support teachers with instruction or curriculum change, and teaching students). Throughout their tenure, they faced challenges and

continued to develop skills in teaching while learning to build and manage relationships and negotiate with existing cultures. Their roles would change from the initial intent and specialists would take on more roles and responsibilities, often taking on the initiative to do so.

Chapter 5: Discussion

The adoption of the Common Core Standards has changed the landscape of mathematics education in the United States. Publishers have updated their mathematics curricular resources to align to these new standards and teachers are having to learn how to use the materials and adopt innovative teaching strategies. To address teachers' learning needs, elementary schools are increasingly hiring math specialists to provide instructional support. However, many math specialists enter into these positions without any formal training and find themselves as novices in their roles.

Through interviewing 16 independent elementary math specialists from schools across the Los Angeles region, my goal was to learn about the process of transitioning into math specialist roles and what math specialists had to learn (in terms of content and pedagogical knowledge and relationship leadership skills), the challenges and support systems at their school sites, the intended purpose of their positions, and whether or not their roles had changed.

In this chapter, I provide a summary of the major findings of the study as well as their significance and limitations, suggest further applications for research, and reflect on how this study has affected me as a researcher and as a math specialist.

Overview of Major Findings

When I started this study, I had preconceived ideas of what I would find in my data, shaped by my own experiences as a math specialist. As I write this chapter, I am completing my fourth academic year as an elementary math specialist at an independent school in Los Angeles, similar to the positions held by the participants in this study. I brought in my own experiences of transitioning into a math specialist role and had an

idea of what conditions and characteristics (as well as previous experiences) would make one successful in this role, as well as the kind of learning that would take place during this transition. However, I realized that my experiences and what I thought I knew did not generalize to all specialists and there were several surprising findings that diverged from my own myopic assumptions.

My most important and surprising finding from the data was that the math specialist must develop supportive relationships, and without such relationships, specialists would be ineffective in their roles (regardless of their knowledge and prior experience). Math specialists who were unable to build relationships at their sites were stifled and unable to wield influence through changing others' instructional practices. Furthermore, this relationship building ability did not rely on their former years of experience in education. In fact, two second-time math specialists had the greatest difficulty establishing relationships at their current schools and faced pushback, and less experienced specialists transitioning from teaching roles within their own schools were more effective. Although math specialists came into their roles with various experiences and occupied various roles, all specialists who saw themselves as successful were able to develop trusting and supportive relationships.

Additionally, the math specialists carried out their roles with a mindset of serving other teachers. This may have worked to their benefit because they did not have administrative or authoritative capacities and needed to create an impact through building relationships and supporting teachers to change their practice, which is often difficult. In this manner, specialists employed a unique and unconventional form of servant leadership.

The specialists who were successful in building relationships did not have a commonality in terms of their roles; what they did on a day-to-day basis (like running professional development sessions or teaching students) was not a correlative indicator of their success. The one thing they all shared was that they were expanding on their roles. They were able to identify the mathematics instructional needs of the school and pitched their ideas; because they had formed supportive relationships, their school community was receptive to implementing their suggestions. In this manner, they were able to change and alter teaching practices as well as increasingly carve out their own roles. These findings are discussed further in the following sections.

Relationships Matter

Overview. The ability to build relationships determined whether or not math specialists could create a significant instructional impact. Much to my surprise, relationship building was foundational to the work of a math specialist, even more so than previous experience, education level, and knowhow. Supportive relationships with colleagues would provide opportunities for the math specialists to build trust and encourage teachers to make changes in their instructional practices, extending their impact outside the confines of their own classrooms.

However, this was not easy to do. The relationships between math specialists and the teachers with whom they work was a strange and tricky terrain because they are not able to evaluate teachers, nor do they have a voice in hiring or firing staff. Their leadership does not come from their position or explicit hierarchy within their school and specialists do not have any formal authority over teachers. Specialists have no

involvement in evaluating teachers or making hiring and firing decisions. Nevertheless, they needed to influence the teachers they worked with.

Specialists had access—in varying degrees—to teachers' classrooms and understood their teaching practices. Even when they were aware of successes and challenges teachers were facing, specialists needed to continue to provide them with instructional support. In fact, the purpose of hiring a math specialist in the first place was to improve mathematics teaching; therefore, specialists should be able to identify challenges in teaching practices and work to support teachers to improve to the extent to which they are capable. In order to support other teachers' teaching practices, specialists had to first build supportive relationships.

First observe, learn, and build relationships. When I first started this study, my focus was on content and pedagogical skills, and I assumed that specialists would stress the importance of honing these skills. Research has shown that programs addressing content and pedagogical knowledge can produce improvements in teaching; therefore, I believed that specialists with these two skills would be better suited for their positions (Boonen et al., 2016; Timmerman, 2014). It turned out that, although content and pedagogical skills are still important to a math specialist, participants stressed relationship building skills and understanding the needs of the school are more important.

The three most common pieces of advice that math specialists would give to new specialists were: first understand the needs of the teachers and school, build relationships with teachers, and learn first before attempting to make changes too quickly. (These three skills emerged from the responses of eight math specialists whereas the other categories were mentioned to a lesser extent.) These three pieces of advice all had a common theme:

a math specialist must observe, learn, understand, and build relationships before making instructional shifts. (Contrarily, this kind of recommendation regarding how to do their jobs best was not in their job descriptions when they first took on their roles. Their predominant job responsibilities provided to them by administration included supporting teachers with curriculum and teaching, teaching students, and working with parents.)

Observational skills. Out of the eight participants who advised that math specialists should take time to understand their school culture and its needs before trying to make changes too quickly, six had not taught previously in their schools. This advice is important, especially for specialists who are external hires, are not yet familiar with the school, and have not built trusting relationships. Trying to make changes too quickly—even if a specialist can identify areas for improvement—without the necessary relationships in place could actually be damaging. It made sense that those who were hired externally emphasized this point because it was a process that they had to undergo.

Vicky and Sherrise were both external hires who echoed this advice. Vicky offered the following advice:

> Find out how you can be of service to teachers initially to make their lives easier, to gain that trust and build those relationships with them. Yes, they want help and yes, they want you to do things with them but don't come in with too much of your own agenda at first. Be very observant, notice what's going on, notice strengths and point those out as much as you can, and then start to push their thinking a little bit where you can, where you can see that they feel somewhat comfortable and then you can push a little bit further.

Creating sweeping changes from the beginning was not a good idea for math specialists; instead, changes needed to be made gradually over time. Understanding cultural patterns, teachers' needs, and how to best approach teachers was important in encouraging them to implement new ideas with which they may be uncomfortable. Therefore, math specialists first needed to develop the relationships necessary to create impact.

Relationship skills. Building relationships with teachers is a difficult task. Interestingly, all math specialists, even those who were building supportive relationships, had faced challenges when working with teachers who were resistant to their ideas. Specialists who are successful and view themselves in this manner also reported that there will be teachers who are reluctant to receive specialists' support. Vicky (who does many of the things that makes one an effective math specialist) stated,

> I feel like there's always going to be people that are like, yes, I'm on it, let's go. There's always going to be people that are like, okay, whatever. And then there are a few resistors to the cause and what you're trying to do.

Even though math specialists faced pushback from resistant teachers, they needed to continue to try to build on those relationships. Elise stated,

> It takes time for everyone to welcome you into the classroom. I was really, sort of hurt my first year that I didn't understand why everyone wasn't welcoming me with open arms. And I had another math specialist told me, "Give it time. Just keep giving them things. Keep coming around. Keep trying to help them and they will come to your side." She was right.

In this regard, being patient with resistant teachers was an important skill to have. Even though math specialists faced pushback from resistant teachers, they needed to continue to try to build on those relationships.

It is difficult for teachers to change their teaching practices and it may be normal to have resistors within the school. It was important for math specialists to build trusting relationships with teachers. This would allow teachers to be open about the issues they were having without fear of professional repercussions. Establishing trust would also happen over time as specialists built relationships with teachers.

Even though math specialists worked with teachers who may have been reluctant to work with them, it was imperative to specialists to attempt to build upon these relationships. They needed to be patient with reluctant teachers and earn their trust.

Learning from teachers they were hired to coach. An unexpected finding from my study was that specialists need teachers not only to implement their ideas, but also to learn from them. This was another reason why relationships with teachers are so important; math specialists are learning from the very teachers they are coaching!

Specialists spoke of working with grade levels with which they were unfamiliar. In order to develop their own content and pedagogical skills necessary to teach as well as to support teachers at these grade levels, they would observe and speak with teachers. For instance, Natalie mentioned that, although she was familiar with upper-elementary grade levels, she had to learn about kindergarten through second grade and did so by observing and learning from other teachers. This was a common theme—one that made logical sense—because elementary math specialists did not and could not have taught all of the elementary grades with which they were hired to work. Specialists managed an

interesting and unique dynamic in which the math specialists were coaching teachers as well as learning from them.

Regardless of their years of experience or education level, specialists spoke of having to learn to work with new grade levels. Veteran educators with over 10 years of teaching experience also mentioned having to learn content and pedagogical skills targeting grade levels they had never taught before. Vicky, who was finishing her doctorate and had experience supervising pre-service teachers at the university level, talked about how she had to learn about teaching sixth grade and how much she learned from the sixth grade teacher. Elise, who had 13 years working in education, also faced this learning curve during her past 3 years as a math specialist working with preschool through sixth grade. She mentioned that she had to talk to the preschool teachers to understand mathematics skills and expectations for this age.

On the other end, Orena, a first-year math specialist, was assigned a mentor teacher who would observe her and provide feedback. Orena's learning was unique in comparison to the other specialists in that her learning curve dealt with classroom management. Orena had strong content knowledge of mathematics and a passion for designing creative lessons; as a result, she already held some expertise that helped her to maneuver her first year working in education as specialist. However, it was apparent that she was still learning some of the skills a first-year teacher has to learn in classroom management, and it was fortunate for her that she was able to build supportive relationships to further her learning.

Learning from other teachers throughout their tenure as a math specialist was a common theme among new as well as veteran educators. Overall, although most

mathematics specialists were hired to coach and support teachers, they were put into positions of coaching teachers and teaching students of grade levels with which they had never worked before. Their relationship dynamic was also why a unique, collaborative set of leadership and relationship building skills was essential for a math specialist.

Conclusion. Overall, specialists needed to utilize a unique type of leadership based on collaboration and support built on trust rather than authority. This was the most important skill to develop because a math specialist could not create meaningful impact without gaining trust, understanding the needs of teachers, and supporting them through making instructional changes.

I found that mathematics specialists needed to build relationships with teachers in order to gain trust so that teachers would allow them to access their classrooms and understand the difficulties they were having in order to improve upon mathematics instruction throughout their schools. Without authoritative power, math specialists had to learn how to build trusting and supportive relationships with teachers as they provided resources and pitched their ideas.

Additionally, math specialists had to employ a unique type of leadership because they were also novices in their roles and learning content and pedagogical skills from the teachers they were hired to support. Thus, being able to build relationships was the key component of whether or not math specialists were able to impact mathematics instruction, more so than any other characteristic. There was a difference in how effectively math specialists managed relationships between those hired within a school and those hired from the outside. This finding is discussed in the following section.

Recommendation. When mathematics specialists are hired, they are not informed of the importance of building relationships within their school. Currently, many training and professional opportunities for math specialists have a heavy emphasis on mathematics content and pedagogy. However, the most difficult part of a specialist's role is that they must learn to develop relationships and act as servant leaders. When designing or enrolling in a training program for specialists, an emphasis on relationship building would be most helpful.

Hired Within the School vs. Externally

Overview. Another finding was that specialists who were hired within their schools were, as a whole, better able to manage professional relationships than those who were hired externally. These specialists were more successful because they had already learned about their school culture, and most importantly, they understood the school culture, how the school functioned, its history, and its people.

Internal hires. The data showed that those who had worked as teachers before they became specialists were more successful at managing and building relationships than their counterparts. This finding countered literature showing that it is not always easy for a professional to transition into a new role within a school (Chval et al., 2010).

Internal hires who pitched the idea for a math specialist at their school recognized a need and persuasively influenced their administrators to create a position for them. Elise recognized a need for curriculum support and believed that the teachers were not being prepared adequately. Because the school valued her and did not want her to leave, they allowed her to take on the role of training teachers. These specialists were able to utilize their relationships and understanding of the school to create a new position to

address a need from the beginning of their math specialist careers. Only specialists with previous experiences were able to create their own roles within their schools.

Additionally, Laurie, who had 15 years of experience at her current workplace, shared that she did not have significant challenges with staff in her role because she had built professional relationships and even friendships with faculty. She stated, "I have been at [my school] for about 15 years, I have gotten to know the people I work with very well…and built up some really solid relationships." Even though she had only been in her current role for 2 years, her former years as a teacher allowed her to enter into her position with supportive connections. Furthermore, Natalie was able to "pop into classrooms" to identify the needs of teachers and design professional development for them. She was able to do this because she had established trusting relationships with teachers and they were comfortable with her visits.

Math specialists who had already built supportive relationships were able to create their own roles and had greater autonomy and influence in carrying out their roles. They also had a level of respect afforded to them that may have lessened the pushback they would face in coaching teachers.

Teacher leader. Furthermore, the specialists who were hired from within their schools were recognized for their leadership and relationship-building capabilities by their administrators at the time of hire. For instance, Jenny, who was formerly a teacher at her school, was able to demonstrate to her administrators that she could teach math and work well with teachers. Even though she was intending to leave her school to pursue an education therapy practice, her administrators were able to convince her to stay by promoting her to a math specialist position.

As teachers, internal hires were able to demonstrate capabilities suitable for becoming math specialists. They showed an aptitude for teaching mathematics as teachers and an ability to forge constructive relationships with teachers without having a formal leadership title. Thus, they had already begun forming the reputations and relationships necessary to become successful math specialists at their schools.

Previous relationships. Having developed relationships with people at their schools (even those that were not in professional capacities) prior to taking on their roles was also instrumental. Orena, who had previously been a parent and synagogue member, had established strong ties to her school community and spoke fondly of her collaborative school culture. Although she had not been employed within her school, Orena had positive relationships within her school community to the point that she had actively sought out the position when she was finishing up her educator credential. Having relationships may have helped her to obtain her position even though she had never taught in a classroom full-time. Although Orena and Vicky are technically outside hires in that they had never worked at their school sites before, having had previous relationships helped them to be hired into their roles as well as to continue to establish new and stronger relationships within their school community.

External hires and previous experience. Initially, I thought that specialists with greater education levels and coaching experiences would be better at carrying out their roles. I made this assumption because research has shown that providing math specialists with extensive content and leadership training can help them to carry out their roles; furthermore, states are providing pathways to the math specialist role and requiring training (Campbell & Malkus, 2014; Swars et al., 2018). However, the data contradicted

my assumption. In fact, education level and former experience had no impact, and in some cases a negative impact on effectiveness.

First, math specialists had held varying levels of formal education. Two first-year math specialists held the highest degree as well as the lowest; John was a veteran teacher who held a doctorate degree in education leadership and Kitty had was a first-year educator with no formal teacher training. It was rather surprising to note that John held a role that was predominantly limited to classroom teaching, similar to Kitty's role. The stark contrast between John and Kitty's previous experiences and education level—in light of the similarities of their roles—demonstrated that prior experiences may not hold as much weight for math specialists in determining their impact. Both professionals were just starting in their roles as first year math specialists and—because they were both external hires—they were having to learn and build relationships at their worksites. They may be able to make significant instructional changes to their schools later on (and I hope they do); however, at the time of the interviews, they were not able to make an impact outside the confines of their own classrooms.

Furthermore, even Hillary and Mill, who had extensive experience as administrators and coaches in previous schools, faced difficulties because they were unable to build relationships at their current sites. Both were stifled in implementing their ideas and faced pushback. Hillary, who started out in her position observing teachers whenever she wanted, was asked by her administrators to do so only when teachers invited her. This was because the teachers were feeling uncomfortable with the random visits. Even though she did not agree with this decision, she became limited in her professional capacity for understanding what was going on in classrooms. Additionally,

Mill expressed frustration that she needed to build relationships all over again, that her position did not allow her to coach teachers as much as she would have liked, and that colleagues were more comfortable with her in a teaching role. Although both Hillary and Mill had built relationships in their previous schools and were accustomed to having their ideas implemented, they could not continue with their pattern of addressing instructional needs the way they were used to doing. Even though they had ideas of what effective coaching models looked like, they needed to start all over in their current schools by building relationships.

In this manner, regardless of former experiences and education levels, all math specialists would need to build supportive relationships prior to making changes in teaching practices of teachers, and attempting to do so without these relationships was met with resistance.

Exceptions of outside hires and former specialists. It is not my claim that math specialists who are hired from outside are unable to build relationships and make an impact. In fact, Landon, Vicky, and Orena serve as examples of math specialists who had no prior working experiences at their sites but were able to build relationships. However, when considering the three specialists, only Landon lacked any prior relationships; the other two had personal ties. In this regard, he may be the only exception out of the 16 participants.

Furthermore, Sherrise had once worked as a math specialist and was an external hire, and she was able to build relationships. However, Sherrise's career trajectory was different from Hilary and Mill's in that she held an administrative internship position prior to her current role (as opposed to holding another math specialist position). Whereas

Hillary and Mill transitioned from successful math specialist roles to their current sites, Sherrise transitioned from an administrative role in what she considered to be a difficult district to her current role. In this manner, Hillary and Mill were the only ones who transferred directly from another math specialist position. However, Sherrise does serve as an example that those who held former specialist roles can be successful at multiple school sites.

Conclusion. Specialists who were hired from teaching positions within their schools held knowledge about their schools and had built positive relationships, upon which they would continue to build as math specialists. Their former relationships provided a significant advantage over those who had started as math specialists at new schools, regardless of their previous professional training or experience. Therefore, having supportive relationships is exceptionally important for a math specialist.

Recommendation. Identifying strong math teachers who have the potential to support other teachers and already have positive relationships with staff members and promoting them into specialist positions may be more effective than bringing in an outside professional. This is not to say that outside hires are unable to build relationships, but it allows the inside hire to be much more effective because the relationships have already been built. It might also be the case that an outside hire may not be able to develop relationships, but this variable would be accounted for if one is hired from within the school.

Additionally, specialists with greater training in their roles were not necessarily effective. Thus, in examining specialist development programs or designing them, it is important to ensure that the appropriate skills are being taught.

Servant Leadership

As demonstrated previously, establishing strong relationships with teachers is fundamental to being able to carry out the role of a math specialist effectively. However, with no authoritative power in evaluating or making hiring decisions, specialists needed to employ a unique form of leadership. These math specialists practiced servant leadership. Servant leaders tend to focus on what is best for others and their growth over their individual interest; they lead with empathy and a commitment to their community. According to Northouse (2015),

> Servant leadership emphasizes that leaders be attentive to the concerns of their followers, empathize with them, and nurture them. Servant leaders put followers first, empower them, and help them develop their full person capacities…[they're] ethical, lead in ways that serve the greater good of the organization, community, and society at large. (p. 226)

Although most specialists did not have formal training in leadership or leadership theory, they were able to describe their approach to supporting teachers in a manner that reflected a servant leadership approach. They provided support to teachers who wanted it and allowed those who were hesitant or reluctant the freedom to choose whether or not they wanted to incorporate the specialists' ideas. Specialists were accommodating to the teachers' comfort level and recognized that change is difficult. Some specialists would also emphasize to teachers that they were the teachers' peers, not administrators or experts. This would further help develop trust and comfort, allowing teachers to be more at ease with the specialists and more open to trying new ideas.

Presenting themselves as authority figures and experts would not work for mathematics specialists. This is partly because they are not experts as math specialists; they are novices to their roles and are continuing to learn. Also, as mentioned previously, math specialists are also continuing to develop their content and pedagogical knowledge of working with students in grade levels they have not taught before. Specialists learn from the teachers they support, and each classroom observation and conversation provides an opportunity to add to their own knowledge base as well as to identify how they can support teachers. In this manner, there was a back and forth exchange of information, ideas, and support between specialists and teachers.

Finally, when asked to rank their strengths, math specialists provided mixed responses about how they viewed their leadership skills; some viewed themselves as leaders and others did not. Their view of themselves may be explained by the fact that servant leadership does not mirror the typical a top-down, authoritative type of leadership. However, a typical approach would not be appropriate for the role of a specialist. Their self-perception as collaborative peers, rather than as leaders, may have helped specialists to build relationships with the teachers with whom they work. It would allow teachers to feel more comfortable confiding in specialists about their challenges and ask for help without the fear of evaluation or professional repercussions. In this manner, specialists would be able to build the types of relationships with teachers that would encourage them to try new teaching practices.

Conclusion. Carrying out their role in a supportive manner while abandoning notions of the stereotypical, top-down authoritarian leader allowed specialists to have ultimately expand their influence. It was a counterintuitive leadership strategy, and

whether or not it was practiced consciously, practicing servant leadership allowed specialists to build relationships to create instructional change.

Changes in Roles

Responsibilities. Mathematics specialists held various roles that entailed coaching and supporting teachers with instruction and curriculum, teaching students, managing parents, and utilizing data. All math specialists held positions that fell into one or more of these categories.

Initially, I had assumed that all math specialists would have some role in coaching teachers; however, this assumption was incorrect. There were specialists who held roles that resembled that of a teacher (like Orena, John, and Kitty) and others (Kathy and Vicky) who were completely removed from classroom teaching responsibilities, working only as coaches for teachers. Most specialists had a combination of duties, including teaching students and working with teachers.

Changes in roles. Over their tenure, the position of mathematics specialists would diverge from the initial job description they were provided. An interesting finding was that the mathematics specialists who were effective in their roles had one thing in common; they were all expanding their influence and carving out their own roles.

Their change in roles occurred happened as they identified the needs of their school and began addressing them. Specialists would pitch their ideas to colleagues and administrators, and with supportive relationships in place, they would be allowed to at least try to implement their ideas. Without relationships, even the most experienced specialists were hindered. In this manner, experience, knowledge, and talent could not

translate into results because math specialists do not function in isolation within their schools; the implementers of their ideas are mostly other teachers.

Furthermore, Rebekah was a standout math specialists in her ability to create impact. She was intentionally building her leadership skills through attending professional development and, in her first year as a specialist, convinced her administration to invite a group of elementary math specialists to discuss pressing issues in mathematics education. Although she was intending to improve her own practices, this group (which she titled Math Consortium) continued to meet and membership was expanding.

Overall, what was unique about effective math specialists was not their individual duties (whether or not they were leading professional development sessions, teaching students, managing parents, etc.), but that they were taking the positions they had and they were expanding upon them. As they recognized the needs of their schools and built relationships, they were able to begin making changes, which influenced other teachers' teaching practices as well as their own. In this manner, they were expanding their roles.

Recommendation. Math specialists should be aware and accept that their roles will change. Those who were most successful were able to build relationships and pitch ideas for improvement, and had their ideas approved. In this manner, as they identified their schools' needs, they became more involved and influential. In this manner, the most successful specialists were able to have a say in how their roles evolved. Math specialists should therefore be aware that the job descriptions they are provided initially and the roles they are given will and should change over time.

Significance of Findings

Initially, I intended to study professional development sessions and I started to lead single sessions at conferences with the belief that I could impact more educators and students; however, through my research, I learned that these sessions are relatively ineffective. Although this was disheartening, I also read that having a mathematics coach available within a school may be the most effective way to ensure that teachers are supported optimally.

Initially when I entered into the field of education, I did not intend to pursue positions of coaching and leadership. However, my success as a classroom teacher opened up opportunities of leadership within my department. From these opportunities, I have realized that I can influence more students by assisting teachers. Throughout my career, I had the privilege to work with dedicated teaching professionals and held leadership roles in several mathematics departments. I served as the teacher leader of a school in the Chicago Public School system. I currently work as a math specialist at an independent school in Los Angeles. In working with teachers, I have experienced firsthand how teachers need continual support in building both their content knowledge as well as their pedagogical knowledge (Shulman, 1986).

I have learned that a math specialist in an independent school setting can have a broader impact on student learning through assisting teachers. Serving in this role requires confidence and the ability to build relationships. A great amount of trust needs to exist in order for a teacher to acknowledge and ask for help regarding understanding elementary math content and pedagogy. I have also learned that there is no manual for how to assist other teachers in this role effectively, and often times, math specialists did

not receive mentorship in their position from their schools (Shulman, 1986; Walkowiak, 2016). Thus, understanding the role and learning required for a math specialist can help guide others (Walkowiak, 2016). Disseminating the findings to other mathematics specialists or those entering into the role will help guide them to better understand and serve in their roles.

In the following sections, I examine the findings of my study that supported as well as diverged from previous research findings.

Relationship building. First, research has shown that hiring math coaches can be more effective than sending teachers to short-term professional development sessions because coaches have access to teachers' classrooms and are knowledgeable about the issues affecting them (Hartman, 2013; Mudzimiri et al., 2014). Although generally math specialists may be more effective than short-term professional development, not all coaches are effective and they need to build relationships first, which can be difficult to do.

Research has shown that specialists must learn and negotiate a complicated school culture, and lack of collaboration within the school structure can limit specialists' work (Hopkins et al., 2017; Smith et al., 2017). Through my research, I learned that relationship building is necessary in order for a math specialist to be effective. Specialists would be unable to gain access to classrooms and knowledge about teachers' issues if they do not develop relationships.

Furthermore, my data demonstrated that even specialists with extensive experience in education and coaching as well as holding an advanced degrees would be ineffective if they were unable to establish relationships at their place of employment.

What they know how to do and what they may have accomplished in the past would not translate into impact in their current positions. All math specialists needed to start by building supportive relationships.

Internal hire. There is research evidence showing that it is more difficult for teachers to transition into coaching roles within their schools, which differs from my findings. Chval et al. (2010) examined cases in which teachers were not receptive to math specialists because they had worked with them as teachers. This transition made it difficult for the teachers to accept the specialist in a new coaching role, and it was uncomfortable for the specialists to have to reshape their professional relationships.

My research demonstrated the opposite finding. Math specialists who transitioned from teaching roles within their schools had less to learn and had established positive relationships and knew about the culture of the school, which was beneficial to them as they continued in their role as specialists.

Continual learners. There is research stating that successful math teachers are typically chosen for the math specialist position (Chval et al., 2010; Fennell et al., 2013). However, the participants in my study had various prior experiences, with two having no full-time teaching experience. This variability of previous experiences was attributable to the fact that independent schools do not need to follow state regulations or recommendations for hiring math specialists. Therefore, some specialists had a much greater learning curve than their veteran counterparts. Furthermore, all math specialists had to work with grade levels with which they had not worked previously. As a result, they were continuing to develop their content and pedagogical knowledge, similar to the

teachers they were supporting. Additionally, math specialists were learning from the teachers with whom they were working.

Overall, my study demonstrated that relationship building is not only important, but it is the key to a math specialist's success. Also, the results from this study diverged with previous research and showed how promoting teachers into specialist positions can be more beneficial than hiring an outside professional. Finally, in practice, mathematics specialists have various backgrounds and are all continual learners who learn alongside and from the teachers they coach.

Research Limitations and Transferability

This study provided an overall narrative in the transition of becoming a math specialist through stories collected in 1-hour interviews of 16 participants. The specialists were in various stages of their careers, and weaving the data together created a sort of timeline progression of becoming a math specialist, from the first to the final years in their profession.

If time had permitted, it would have been informative to conduct a longitudinal study of these specialists to see the changes that occur in terms of their impact. The data lead me to believe that even the most novice math specialists who are able to build relationships will expand their influence over time. When writing about Orena and her lack of teaching experience, I did not intend to be disparaging of her potential. In fact, I believe that she has the necessary relationship building skills and support as well as mathematical know-how and vision to become a tremendously influential math specialist. I see great potential and passion in her, and it would have been interesting to follow the progression of her career as well as those of the others.

This study was limited to elementary math specialists in independent schools in the Los Angeles region. There were a few unique characteristics that may possibly limit transferability to a certain extent.

One difference was that these specialists had come together to create the Mathematics Consortium group, which allowed specialists to share information as well as to develop relationships with each other. By the time of this research, the group was in its third year and I was also a participant. I know from experience that this group had made a tremendous impact on my own professional career and it has done so for others, and a similar support structure might not be available in other areas.

Also, independent schools in Los Angeles have a unique climate, one that serves students and parents of higher socioeconomic levels. This may not mirror the demographics of other independent and public school districts across the country. Math specialists spoke of pressures on students to test well on the ERB exams for entrance into independent middle schools and specialists had to understand how to work with this data, which may not be important in other schools. However, the outgrowth of differing socioeconomic levels might be a small discrepancy given that independent and public schools do have testing pressures, even though they may take different exams.

Finally, participants had a broad range of previous experiences, from those who were veteran educators to those who were completely new to the field of education. This variability was due to the fact that independent schools are not regulated in how they make their hiring decisions. Thus, the manner in which specialists were hired and the level of experience and knowledge they brought into their positions varied. This lack of

regulation may differ with the background experiences that public school districts require of their prospective math specialists.

The main findings of this research study should still apply to most positions of mathematics specialists.

Suggestions for Further Research

This study was not intended to gauge the effectiveness of mathematics specialists; rather, I focused on what they needed to learn and adapt to throughout their transition. I understand that there are other characteristics and attributes that would influence whether or not a specialist is effective. If a mathematics specialist is capable of building relationships but has terrible ideas that are then implemented, this would inevitably be detrimental to the mathematics department as a whole. Initially, I did entertain the idea of interviewing administrators and teachers to understand their perspective on the math specialists to determine if I could gauge effectiveness, but I realized that this was beyond the scope of my research. However, further investigation would add to our current body of knowledge.

Furthermore, although I found that the ability to build relationships is a necessary component of leading instructional change, I was not able to thoroughly examine how they are able to do so. Understanding how to build these unique relationships would benefit math specialists as well as those supporting them.

Finally, my findings demonstrated that math specialists' experience and education level did not correspond with whether or not they could establish relationships at their current worksites to create impact. An examination into formal training offered to those

who become specialists to understand what is actually useful would provide valuable information for designing training or credentialing programs for math specialists.

Conclusion

The position of a math specialist is a difficult one. To be effective in their roles, specialists must be able to persuade other teachers to implement their ideas, which may cause discomfort and require additional work, without any administrative authority. Furthermore, specialists need to build professional trust and confidence, while at the same time, they themselves are novices in their positions and are continuing to build content and pedagogical knowledge. It is a tricky balance, one that must be navigated diplomatically. Specialists shared with me their struggles and successes, and they taught me that with strong relationships, they can shape instructional practices at their schools as well as create impact and broaden their influence.

Final Thoughts

I had met a few of the participants through the Mathematics Consortium before I decided to do this research project. It was unique and interesting to me to hear the stories of these specialists, some who have made an indelible impression on my own career. Throughout my past few years as a math specialist, they have helped me find resources, advised me through difficulties, and been a support system throughout my own growth and transition process.

I deeply appreciate the mathematics specialists who shared their stories with me. I hope that this research project can help others to manage this challenging and impactful role with grace and confidence.

APPENDIX A

Relationship between Research Questions, Data Collection Methods, and Units of Observation

Research Questions	Data Collection Methods	Units of Observation
According to the mathematics specialists, what did they have to learn in terms of content knowledge, pedagogical skills, and relationship-building and leadership skills?	Interviews of mathematics specialists and artifact analysis	❏ Developing content knowledge ❏ Developing pedagogical skills ❏ Professional development ❏ Mathematics Consortium ❏ Learning from other teachers ❏ Independent learning - Relationships, success and challenges with: ❏ Teachers ❏ Administrators ❏ Parents ❏ Students
According to the mathematics specialists, what were the challenges and support systems present at their school sites?	Interviews of math specialists	- Challenges that varied by manner of hire: ❏ Teachers hired to be specialists within the same school ❏ External hires ❏ Second-time specialists ❏ Managing friction with teachers ❏ Advice they would give to new math specialists - Relationships, challenges and support from relationships with: ❏ Teachers ❏ Administrators ❏ Parents ❏ Students
According to the math specialists, what was their initial intended purpose for their roles, and how has	Interviews of mathematics specialists	- Positions was intended to: ❏ Replace former math specialist ❏ Support teachers with instruction and curriculum ❏ Support teachers with curriculum change

this changed, if at all?		❏ Teach students ❏ Created own role ❏ Following trend of hiring a math specialist ❏ Manage parent relationships ❏ Improve test scores - Actual roles consisted of: ❏ Teaching students ❏ Coaching teachers ❏ Leading professional development ❏ Using data to improve instruction ❏ Managing and working with parents ❏ Unique roles

APPENDIX B

Phone Call Prior to Interview

Researcher Introduction

Hello. My name is Christin Ahn and I am the mathematics specialist at Brawerman Elementary School. I am working on my dissertation research project at UCLA trying to understand what it means to be a mathematics specialist in independent schools I am trying to speak with every K-8 independent school math specialist in LA. Could I ask you a few quick questions before you agree to the interview? Anything you tell me is confidential and your name will not be shared.

What is your official title? How long have you had your position? How long have you been teaching? Have you received any specialized training for your job?

Would you be willing to talk with me more specifically about how you see your position as a mathematics specialist?

Interview Questions

Opening

You mentioned on the phone that you've been in your current position about ___ years. Could you describe a typical day for me in your work right now?

Opening

- Tell me how you got your current position.
- What did the school communicate to you regarding their reason for wanting to hire a math specialist?
    - Has the schools' goals or plans changed since you began?...
- What position did you have prior to your current position as math specialist? How did your previous experience as a _____ influence the way you see your role as a math specialist? What has been your best experience as a math specialist? What is a real success that you felt?

Artifact Analysis

- What are the two items you brought to share with me? Can you tell me about them and why you selected to share them with me?

Learning—content, pedagogy, leadership

Support

- When you started in your role, what training / professional development (in terms of math content, pedagogy, leadership and relationships) did you receive, if any?

- Could you tell me about an individual or individuals who were supportive of you (in terms of math content, pedagogy, leadership and relationships/ someone at school who encouraged you)?

Challenges

- Could you tell me a story about something you found challenging in your role (in terms of math content, pedagogy, leadership and relationships)?
    - if they don't mention follow up with:
        - What was challenging in terms of the math content itself?
          What was challenging in terms of math pedagogy, either for you or in helping teachers with pedagogy?
          What was challenging in terms of your new quasi-leadership position?
          What was challenging in terms of your relationships with teachers? With administrators? With students/parents?
- What do you think are your top three strengths as a math specialist? What do you think you are good at?
    - If you were to rank your strengths in math content, pedagogy, leadership and relationships, which of those four do you see as your strongest area? (then have then share their weakest area, always asking for details regarding why they said that)
        - Probe specifically about relationships…etc. (if not brought up)
          I heard you mentioned a few challenges… were there any others?
          Is there a particular story you could tell me about… relationship, knowledge…

School Environment

- What would you say is special about your school? (Follow up with: priorities and pressures, demographics, religious affiliation, etc.)
- How do you feel about the parent expectations for mathematics teaching at your school?

Closing

- What advice would you give to a brand-new math specialist, either at your school or a different school?
- Anything else about being a math specialist that I have not asked you yet?
- I am trying to speak with every math specialist that I can and I was wondering if you knew of anyone who would…

APPENDIX C

Informed Consent

UNIVERSITY OF CALIFORNIA, LOS ANGELES
Consent to Participate in Research

Researcher: Ms. Christin Ahn, M.S.Ed

Protocol Title: Stories from Mathematics Specialists: Transitioning from Classroom to Coach

DESCRIPTION: You are invited to participate in a research study about elementary mathematics specialists in independent schools throughout the Los Angeles region for the purpose of learning on how mathematics specialists transition into their roles from full-time teaching. You will be asked to participate in an interview which will be audio recorded and transcribed. You may be contacted to participate in a follow-up interview.

TIME INVOLVEMENT: The interview will take approximately one hour. A potential follow-up interview will take between 10-30 minutes.

RISKS AND BENEFITS: The risks associated with this study are minimal. Your identity will be kept confidential and your name will not be used in any reports resulting from the interview. Any identifiable information will be coded and stripped from identifiers. your identity will be kept confidential.

PAYMENTS: You will receive a gift card of $10 as payment for your participation.

PARTICIPANT'S RIGHTS: If you choose to participate, you have the right to decline to provide an answer to any question during the interview while still remaining in the study. You also have the right to end the interview, to ask me to stop and restart the recording, withdraw your consent, and discontinue participation at any time without penalty.

CONTACT INFORMATION:
Questions: If you have any questions or concerns, contact the researcher, Ms. Christin Ahn, at [redacted] or ([redacted], and UCLA faculty Dr. Diane Durkin at [redacted] or Dr. Megan Franke at [redacted]

Independent Contact: If you have questions about your rights or you have concerns and you wish to contact someone other than the researcher, you may contact the UCLA OHRPP by phone: [redacted]; by email: [redacted] or by mail: Box 951406, Los Angeles, CA 90095-1406.

Indicate ***Yes*** or ***No***:
I give consent to be audiotaped during this study.
___Yes___No

This document needs to be sent back to the researcher before the interview takes place. The extra copy of this signed and dated consent form is for you to keep.

SIGNATURE _____ DATE _____

Print name of participant _____

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