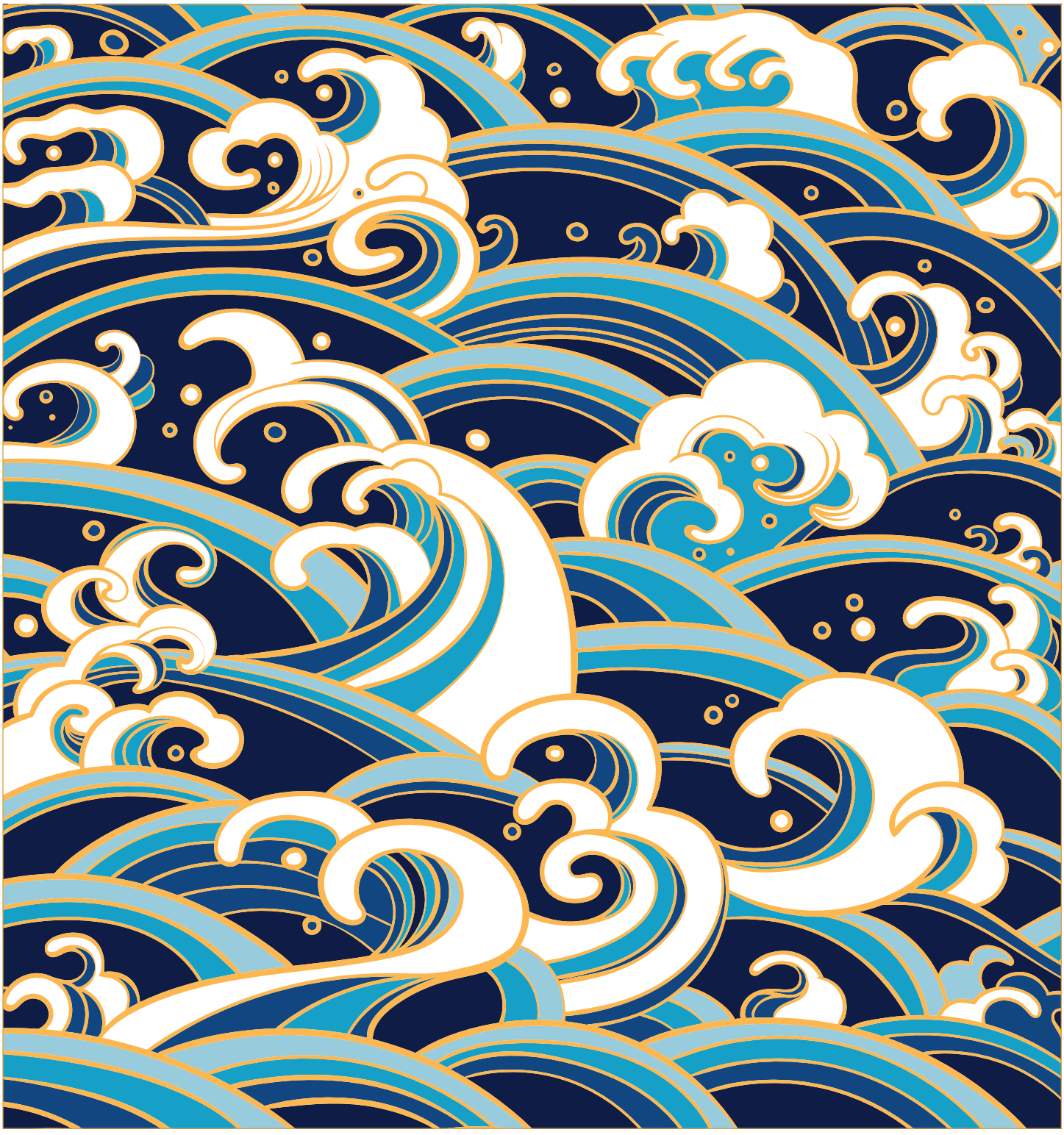
NCSM Journal

of Mathematics Education Leadership

SPRING/SUMMER 2019 VOL. 20, NO. 1



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Call for Manuscripts

The editors of the ***NCSM Journal of Mathematics Education Leadership (JMEL)*** are interested in manuscripts addressing issues of leadership in mathematics education which are aligned with the NCSM Vision.

The editors are particularly interested in manuscripts that bridge research to practice in mathematics education leadership. Manuscripts should be relevant to our members' roles as leaders in mathematics education, and implications of the manuscript for leaders in mathematics education should be significant. At least one author of the manuscript must be a current member of NCSM.

Categories for submissions include:

- Case studies and lessons learned from mathematics education leadership in schools, districts, states, regions, or provinces
- Research reports with implications for mathematics education leaders
- Professional development efforts including how these efforts are situated in the larger context of professional development and implications for leadership practice
- Other categories that support the NCSM vision will also be considered.

Submission Procedures

Each manuscript will be reviewed by two volunteer reviewers and a member of the editorial panel.

Manuscripts should be emailed to the Journal Editor, currently Carolyn Briles, at ncsmJMEL@mathedleadership.org.

Submissions should follow the most current edition of APA style and include:

1. A Word file (.docx) with author information (name, title, institution, address, phone, email) and an abstract (maximum of 120 words) followed by the body of the manuscript (maximum of 12,000 words)
2. A blinded Word file (.docx) as above but with author information and all references to authors removed.

***Note:** Information for manuscript reviewers can be found at the back of this publication.

NCSM–LEADERSHIP IN MATHEMATICS EDUCATION

Inquiries about the ***NCSM Journal of Mathematics Education Leadership*** may be sent to:
Carolyn Briles
19019 Upper Belmont Place
Leesburg, VA 20176
Email: ncsmJMEL@mathedleadership.org

Other NCSM inquiries may be addressed to:
NCSM–Leadership in Mathematics Education
PO Box 3406
Englewood, CO 80155
Email: office@ncsmonline.org • ncsm@mathforum.org

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NCSM Vision

NCSM is the premiere mathematics education leadership organization. Our bold leadership in the mathematics education community develops vision, ensures support, and guarantees that all students engage in equitable, high quality mathematical experiences that lead to powerful, flexible uses of mathematical understanding to affect their lives and to improve the world.

Purpose Statement

The purpose of the NCSM Journal of Mathematics Education Leadership is to advance the mission and vision of NCSM by:

- *Strengthening mathematics education leadership through the dissemination of knowledge related to research, issues, trends, programs, policy, and practice in mathematics education*
- *Fostering inquiry into key challenges of mathematics education leadership*
- *Raising awareness about key challenges of mathematics education leadership in order to influence research, programs, policy, and practice.*

Comments from the Editors

M. Carolyn Briles, *Loudoun County Public Schools*
Brian Buckhalter, *Buck Wild About Math, LLC*

"Your assumptions are your windows on the world. Scrub them off every once in a while, or the light won't come in."
- Alan Alda

False assumptions are dangerous business, and if they aren't corrected, they undermine our leadership. They sabotage communication by making us deaf to what is really being said. They disguise problems so that we are unaware of their root causes. Assumptions set us up for failure that comes as an unwelcome surprise. We think we are on the same page as colleagues with respect to goals, values, and plans, only to find out that our energy has been misguided in the opposite direction. As a leader in mathematics education, what assumptions do you carry? This issue of JMEL focuses on some of those assumptions and how they might affect our daily practice.

What do you assume about the teachers you coach? Do you share the same values and professional goals? Do your ideal educators look the same? Do you have a common vision for what learning looks like? In our first article, Wills and Rawding offer a tool to help us find out. In "Positive & Productive Coaching: An Interview Protocol and Systematic Approach for Creating Coaching Goals," the authors outline a set of questions to guide initial interactions in a coaching relationship. The inclusion of a perfect world scenario helps reveal the perspective and mindset of the teacher being coached before assumptions can paint a misleading picture.

What do you assume about the scope and sequence of your curriculum? Is it defined at the district level? The building level? What drives the decisions about where concepts are placed? We assume we begin the year with a common vision for instruction, but our second article shows how wrong we are. In "Discontinuity in Enacted Scope and Sequence of Middle Grades Mathematics Content," Kasmer, Olson, Teuscher, and Dingman show us that the sequencing of concepts is surprising dissimilar, even under the unifying structure of the Common Core State Standards for Mathematics.

And finally, what do you assume about teachers' needs? Are the things that we believe are important to teachers really important to them? Or do we offer solutions to problems they don't have while ignoring the ones they do? Our last article, "What Educational Leaders Need to Know About Early-Career Mathematics Teachers," examines what teachers really need by actually going to the source – the teachers. What Martinez and Amick found may surprise you.

We hope summer finds you with time to refresh and renew your energy. We hope you will tuck this issue of JMEL in your carry-on bag and take it to a place where you can reflect on your year in quiet retrospection. We hope this issue will cause you to think about assumptions in your own leadership practice, and most importantly, to scrub them off so the light will come in. ✪

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Positive & Productive Coaching: An Interview Protocol and Systematic Approach for Creating Coaching Goals

Theresa E. Wills, *George Mason University*
Molly Rawding, *Lexington Public Schools, Lexington, MA*

Abstract

Mathematics coaches have an immense responsibility to uniquely coach a diverse group of teachers in "areas related to standards, curriculum, assessment, and professional development" (AMTE, 2010, p. 1). Because of the diversity of teacher's needs and school settings, it is important that a coach establish personalized goals with each teacher. Establishing these goals and making sure they are effective requires a positive and trusting relationship with the teacher based on shared values. This article outlines an interview protocol to guide initial interactions and a systematic approach for identifying a coaching goal. Included is a sample interview, an analysis of the interview questions, and strategies for creating a productive and positive interview. By using this interview protocol, the coach will be able to select purposeful questions, build a positive relationship with the teacher, and obtain the necessary information to help create an effective coaching goal.

Introduction

Mathematics coaches have the prodigious task of working with teachers "in a professional development capacity or to target school-wide improvement in mathematics" (AMTE, 2010, p. 1). Coaches must consider math content, teaching practices, and professional relationships while intentionally planning to support individual teacher needs (Baker & Knapp, 2019). Vislocky (2013) states that for long-term impact, effective professional learning needs to be sustained over time, relevant to the needs of the learning community, focused on deepening content knowledge and pedagogy, and engaging for teachers as learners. Mathematics coaches are often "left to their own devices to figure out their job—where to work, who to work with, what to do, and how to actually increase student learning" (Hull et al., 2009, p. x). It can be challenging for a coach to know where to begin which is why Confer (2006) suggests building good relationships with teachers as a coach's first priority.

Those relationships are affected by coaching style. Knight (2009) describes two coaching styles; coaching light, which prioritizes building strong relationships, and coaching heavy, which uses high stakes interactions with the teacher and uses data to determine how to support them in planning, instruction, and assessment. Another challenge for coaches is deciding how to balance coaching light and coaching heavy (Knight, 2009). West and Cameron (2013) suggest beginning with, "What are the develop-

mental needs of this teacher?" in order to determine the specific goals and not become distracted with improving other aspects of the teaching and learning. Morse (2009) describes the importance of identifying teacher's wants and needs in order to create coaching goals.

But while experts agree on what is important in the goal-setting process of coaching, few offer how to get there. We offer an interview protocol that can be used to build positive relationships with teachers that encourages open-ended reflection as a way to discover teachers' values. The interview protocol incorporates a perfect world scenario and was created to balance coaching light and coaching heavy, while also identifying the developmental needs of the teacher and providing a clear direction for the coach.

Relationships as the Foundation for Goals

While coaching goals can seem nebulous, they all begin with relationships. The National Council of Supervisors of Mathematics (NCSM) lists relationships as one of the four foundational elements of coaching (NCSM, 2019, p. 33). This was echoed by a group of math coaches using a baseball analogy. When asked, "What should a baseball coach do first when coaching a new team?" one coach responded that they should "introduce yourself and build relationships with the team." Another said, "I think that by seeing what they [the players] can do now, watching them field the ball, you'll have better information on where to start with them." Another added, "When you pre-assess and focus on what they do well, it leads you to building that positive relationship because you can highlight what they are already able to do." In considering a sports team, these math coaches articulated the importance of building relationships and pre-assessing strengths in order to create coaching goals in working with mathematics teachers.

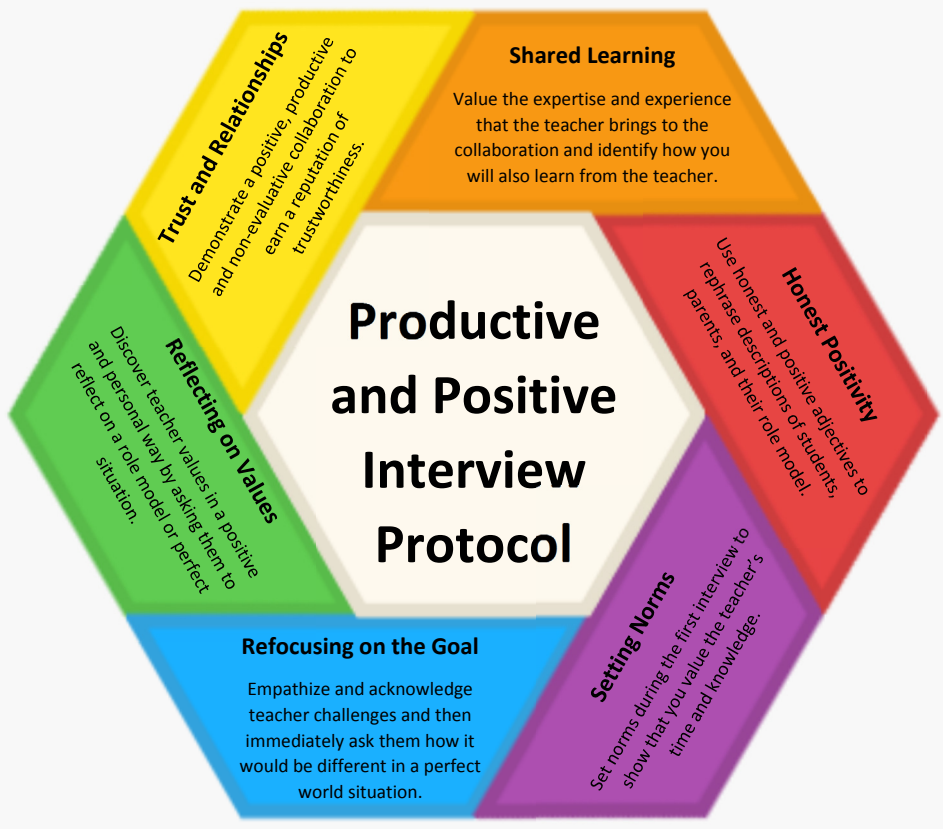
An Interview Protocol to Build Relationships

The interview protocol that we have designed is based on six interrelated themes of productive and positive questioning: trust and relationships, shared learning, honest positivity, setting norms, refocusing to the goal, and reflecting on values.

In addition, it implements a *perfect world scenario*. This strategy is a productive and positive way to discover teachers' values by asking them to describe perfect classrooms. The strategy does not diminish the obstacles and challenges that teachers face which can be perceived as condescending and undermine trust. Instead, it encourages the teacher to describe best practices from their own experience which establishes common ground and values. This foundation then allows for recognition without excuses and provides a path towards a productive end goal.

We share the transcript of an initial interview with a veteran third grade teacher using this protocol and then analyze it with respect to the six themes.

FIGURE 1. *Themes of the Interview Protocol*



Interview

Coach: *It is a pleasure to be with you today. You have a reputation of being a hard-working, passionate, and thoughtful teacher, and I am happy to share in our learning together. Before we begin, I'd like to learn a little about you and your experience as a learner. Who was your greatest teacher?*

Teacher: *Hmm, well, Mr. Jones. He liked his students and held them to high standards.*

Coach: *How did he show that he liked his students?*

Teacher: *He had a lunch club where all students were invited to eat in his room. We could goof around or be tutored, his only rule was that we were kind to each other.*

Coach: *Wow, what great characteristics, are there other ways that he showed that he liked students?*

Teacher: *Uh...He was always very respectful and gave us chances, but as long as we were respectful.*

Coach: *It sounds like he both showed and valued respect.*

Teacher: *YES! He even memorized our names on the first day, and greeted us at the door every single day.*

Coach: *You also mentioned that Mr. Jones had high standards, what did he do to show you this?*

Teacher:*Well, he never accepted late assignments - NEVER! He said that in the real world, people wouldn't give you extensions. But, he always gave a big project at the end of the semester for extra credit. The project was hard, and the people who did it worked for a long time on it.*

Coach: *He sounds fair, is this something that you value in your classroom?*

Teacher: *YES! Students should turn in their homework every day, and if they don't, I don't like to get excuses from their parents. I remember how Mr. Jones taught me the importance of a deadline, and everyone in his class always had homework ready. Students didn't whine to him or make excuses.*

Coach: *What are some strategies that you learned from that great teacher that you use to support students in your class?*

Teacher: *Definitely learn everyone's name on the first day, and greet them at the door. You have to let them know your rules and expectations, and stick to them.*

Coach: *I want to know more about what you value in a classroom. In a perfect world, what would the students know and be able to do?*

Teacher: *They would listen to my instructions and show that they can think and problem solve in small groups. That way, I wouldn't have to lecture the whole time. I want them to work together to solve really hard problems.*

Coach: *What would be your role as a teacher in this perfect world?*

Teacher: *To help students with math problems, and not always have to deal with kids who are playing around or goofing off. I'm always having to sit right next to this one group of kids because they get off track right away...they are always arguing with each other the second it is time to work together.*

Coach: *We do have so many challenges, but what if we didn't, what if it was your perfect world? What would your role be as a teacher?*

Teacher: *Well, if it was perfect, I would get time to sit with groups for like 3-5 minutes and help them solve their problems. Oh, and students who need my help would know to wait until I was standing, then raise their hands. They would also know what to do while they were waiting for me.*

Coach: *It sounds like you really value student independence.*

Teacher: *YES! Exactly.*

Coach: *I also value student independence. Now...we will plan some lessons next meeting. What standard will we plan?*

Teacher: *Um...the next unit is Algebra and Patterns.*

Coach: *Have you started this yet, or will this be the opening lesson?*

Teacher: *Well, I think...we will practice some patterns next week, but nothing with algebra.*

Coach: *Ok great to know. I'm curious, teachers like to be acknowledged for incredible teaching in different ways. Some like personal notes, others like announcements during staff meetings, and others prefer documented emails. How do you like to be acknowledged for outstanding lessons? (McLoughlin, 2011)*

Teacher: *Well don't make a big deal at a faculty meeting for one. That is just embarrassing. I like when people who observe me leave a note on my desk. You really don't need to make it a big deal.*

Coach: *When we are working together, what are three things that are important to you?*

Teacher: *Um, well definitely being on time and getting stuff done, and also knowing how long things will take to teach. I just want to use the time to actually plan stuff and not just talk.*

Coach: *Great. Here are three things that are important to me: Being on time, working through the math together, and valuing mistakes.*

Coach: *Now that I've learned a bit more about you, I can plan with your values in mind. From now on, we will jump right into planning, just like we jumped right into this interview to value our time together.*

Interview Analysis and Guide

The table on page 7 identifies the six themes of productive and positive questioning, when to use them, and how they were implemented in the interview above.

Reflections on Using the Protocol

This interview protocol has been implemented over 100 times as coursework by math coaches at George Mason University. A key element of it is interweaving the perfect world scenario with the six themes. Here are coaches' reflections on their experiences.

Perfect World Scenario

The perfect world scenario strategy offers a non-threatening, non-evaluative process for teachers to share their values. In this strategy, teachers are prompted to describe a specific component of the world they wish for. Since the situations described are rooted in the teachers' own experiences, the values that emerge from them have more credibility in the goal setting process. Coaches can also apply the perfect world scenario to their own coaching. Pamela connected the perfect world scenario with the idea of growth mindset:

> It just reminds me so much of the growth mindset that I am familiar with as a teacher that it's the same perspective as a coach. Just like teachers expect students to continually grow and change, the coach needs to realize that teachers are continually going to grow and change. Thinking about the perfect world, I think it is so important as a coach because you're the positive light in the midst of many challenging situations. Aliyah used the perfect world scenario because "it gives the strength to get through those obstacles."

Since it can be difficult for some people to talk about themselves, asking teachers to describe a role model is another way to ask them about their perfect world. Saanvi admitted that "usually I don't want to talk about myself" but when asked about her perfect world scenario, she reflected on the ease of which she could "explain or paint a picture of an experience or a specific situation and I didn't feel super awkward when I was talking about myself." These reflections highlight the benefits of using a perfect world scenario in an interview to focus on the positive and the possible.

Listening and Notetaking

For the procedural element of the interview protocol, it is important to listen and take notes once the teacher is describing their perfect world scenario and values. The process of actively listening and taking notes focuses the coach. In addition, it shows respect and demonstrates genuine interest, which, in turn, develops a positive relationship.

However, this can be challenging. As Bri recalled, "It is a little hard notetaking and [listening] at the same time." While it may be awkward for the interviewer, Saanvi, the interviewee, explains how she appreciated the interviewer pausing and writing down her responses because "she was really listening and she was appreciating the intricacies of the way I liked to assess students...you wouldn't be offended if someone said, 'Oh, that's important to me, I want to write that down'." Bri explained that when she wrote down responses it "really forced me to be an active listener and I sometimes anticipate what people will say and it forces me to just listen truly to their words first and how to find what is valuable to them and that is helpful for me then to have that common ground with them." Liza commented on the importance of notes on feedback based on a teacher's definition of a perfect world. She said, "When I interviewed the teacher, it was interesting to know all those things that they value so we can note that and name that when we see that happening [in the classroom]."

Table 1: Purpose and Highlights of the Interview

TRUST AND RELATIONSHIPS. Demonstrate a positive, productive and non-evaluative collaboration to earn a reputation of trustworthiness.
To Promote Trust Relationships ask: • "...I'd like to learn a little about you and your experience as a learner. Who was your greatest teacher?" • "...teachers like to be acknowledged for incredible teaching in different ways. Some like personal notes, others like announcements during staff meetings, and others prefer documented emails. How do you like to be acknowledged for outstanding lessons?" • "...what are three things that are important to you?... Here are three things that are important to me...."
SHARED LEARNING. Value the expertise and experience that the teacher brings to the collaboration and identify how you will also learn from the teacher.
To Promote Shared Learning include: • "I am happy to share in our learning together." • "We will get to plan some lessons in the future." • "Mistakes are valuable. As we work together, we may make mistakes doing the mathematics and that will be a really important part of our work. It's important students see that we make mistakes too. "
HONEST POSITIVITY. Use honest and positive adjectives to rephrase descriptions of students, parents, and their role model.
To Promote Honest Positivity include: • "It is a pleasure to be with you today." • "You have such a reputation of being a hard-working and thoughtful teacher," • Rephrase the teacher's words using positive descriptors.
REFLECTING ON VALUES. Discover teacher values in a positive and personal way by asking them to reflect on a role model or perfect situation.
To Reflection on Values ask: • "What would be your role as a teacher in this perfect world?" • "What are some strategies [about your role model teacher] that you learned to support students in your class?" • "I want to know more about what you value in a classroom. In a perfect world, what would the students know and be able to do?"
REFOCUS ON THE GOAL. Empathize and acknowledge teacher challenges and then immediately ask them how it would be different in a perfect world situation.
To Refocus the Discussion ask: • "We do have so many challenges, but what if we didn't, what if it was your perfect world? What would your role be as a teacher?" • "We will get to plan some lessons in the future. What standard will we plan for in our next meeting?" • "Have you started this yet or will this be the opening lesson?"
SETTING NORMS. Set norms during the first interview to show that you value the teacher's time and knowledge.
To Establish or Confirm Norms ask: • "...From now on, we will jump right into planning, just like we jumped right into this interview to value our time together." • "If we want kids to make mistakes, what specific steps will we do when we see a mistake?"

Practice

The authors recommend rehearsing and refining your interview through practice and reflection. The math coaches conducted this interview at least three times in order to refine their skills and confidence. Shawna commented,

> I have done this last semester and I remember feeling really awkward, and this time I felt more comfortable with it. It felt like it flowed better, and I just felt a lot more comfortable. So that reminded me of the quote (by Virgin Thomson) "Try a thing you haven't done three times. Once, to get over the fear of doing it. Twice, to learn how to do it. And a third time to figure out whether you like it or not."

West and Cameron (2013) recommend rehearsing coaching conversations specifically to practice word selection, tone, and body language. By rehearsing the interview before it is given to the teacher, the coach can refine the questions while discovering their math identities. When interviewing the teacher, the coach should note the values that are addressed either directly in the perfect world scenario or indirectly in the description of their role model teacher. Then the coach should be ready with follow up questions to gain more detail.

Values To Goals

Once the interview protocol has revealed a teacher's values and developmental needs, the focus can shift to creating effective coaching goals with the teacher. An often-overlooked step when creating these goals is for the coach to know thyself. The safe relationship between coach and teacher must be based on trust and transparency (NCSM, 2019, p. 34), and the best of those relationships are two-way. By creating a comprehensive list of skills, interests, passions, and non-interests, the coach can become aware of their own math identity as they work to help others find theirs. Relative topics might include problem-solving,

FIGURE 2. *Single Circle of Values*

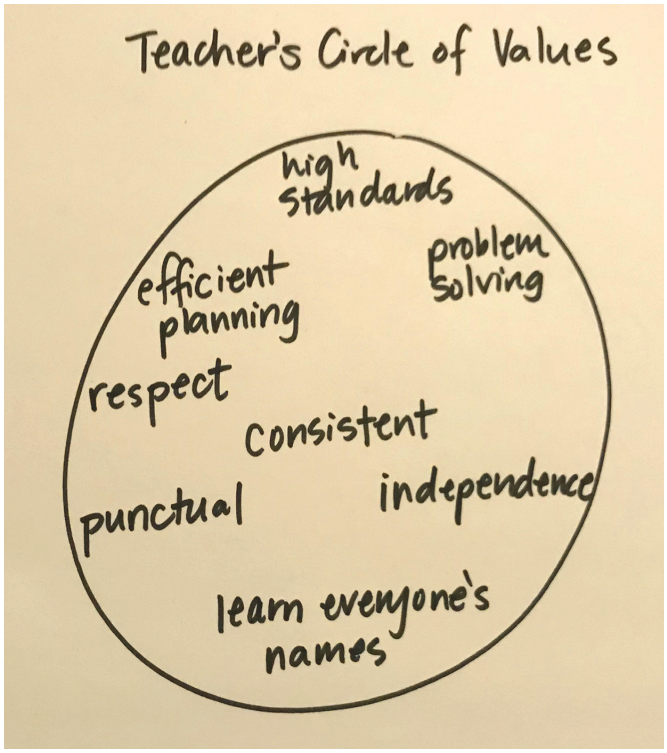
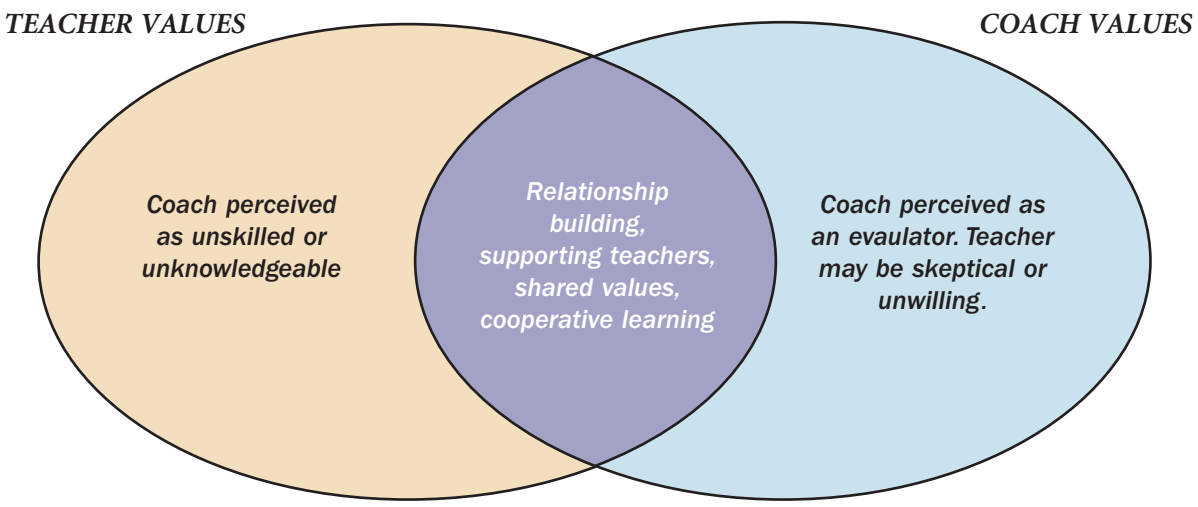


FIGURE 3. *Venn Diagram of Values*



mistakes, productive struggle, homework, working in groups, and parent involvement. Whenever possible, the coach can discover these values by using the perfect world strategy on themselves.

Creating a circle of values is a strategy that can be used to identify and compare the skills, values, and passions of both the teacher and coach. Simply put, if a term describes the person, it is written inside the circle; if not, it is written outside. By creating two circles of values, one for the coach and another for the teacher, coaches can use a Venn diagram to identify potential coaching goals. Shared values would be in the intersection of the circles revealing a good starting point for the creation of goals.

The Venn diagram can also be used to determine areas not to coach until a strong relationship has been established. For example, if math talk is in the coach's circle, but not in the teacher's circle, the teacher may not be ready to see the purpose/impact and there may be skepticism, hesitation, or unwillingness to participate. Alternatively, if the teacher values something that the coach does not, the coach may appear unknowledgeable or unskilled. Finally, the coach should continuously update the Venn diagram in order to identify topics for further coaching goals.

Summary

In summary, when the coach listens to the teacher in order to discover shared values, they can create coaching goals that are purposeful and focused. The Productive and Positive Interview Protocol introduced here is a way to begin conversations that develop relationships of trust so that teachers feel safe enough to share their values. Once values are expressed and recorded, the coach and teacher can analyze them and refine them to become coaching goals. ✪

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Discontinuity in Enacted Scope and Sequence of Middle Grades Mathematics Content

Lisa Kasmer, *Grand Valley State University*
Travis Olson, *University of Nevada Las Vegas*
Dawn Teuscher, *Brigham Young University*
Shannon Dingman, *University of Arkansas*

Abstract

The 2010 release of the Common Core State Standards for Mathematics (CCSSM) initiated a tremendous effort to align the mathematics curriculum across the United States. However, the work of enacting these standards, including determining the order to teach grade-level standards, was often left to local schools and district experts to determine. These decisions were influenced by several factors and often formalized in scope and sequence documents, which outlined the order in which grade-level standards would be taught and the amount of time devoted to specific mathematical content and skills. In this paper, we report the analysis of eight Grade 8 mathematics teachers' scope and sequence documents and the underlying factors that influenced their development. Given the discrepancies apparent across these eight documents, we discuss the implications stemming from these curricular decisions and recommend district leadership consider the connections across mathematical content when making decisions regarding the sequencing of topics in any grade level.

Introduction

There is widespread agreement among scholars that curricular coherence is important. The National Mathematics Advisory Panel (2008) defined a coherent curriculum as "marked by effective, logical progression from earlier, less sophisticated topics into later more sophisticated ones" (p. xvii). The Third International Mathematics and Science Study (TIMMS) acknowledged that curricular coherence was the foremost predictor of student performance (Schmidt, Wang, & McKnight, 2005). Furthermore, there are "strong theoretical reasons to expect that a coherent approach to learning, in which learners are supported in deepening their developing ideas by connecting them to multiple contexts of use, should be effective" (p. 525). NCTM further elaborates the significance of curricular coherence as they define mathematical connections in *Principles and Standards for School Mathematics* (2000) as the ability to "recognize and use connections among mathematical ideas; understand how mathematical ideas interconnect and build on one another to produce a coherent whole" (p. 64).

To create this curricular coherence, schools and districts often develop scope and sequence documents that specify the order of the mathematics content that teachers should teach throughout the school year as well as the amount of instructional time teachers should devote to these topics. While the Common Core State Standards for Mathematics (CCSSM) outlines the knowledge and skills that should be

the focus of instruction at each grade level, it also allows for flexibility for the implementation of these standards: it does not dictate the curriculum, teaching methods, or the scope and sequence of topics at any grade level (CCSSI, 2011). Consequently, pedagogical decisions for how to teach the content in the CCSSM remain open to interpretation (Munter, Stein & Smith, 2015).

When teachers use a mathematics textbook, the book has the potential to become the default scope and sequence for the mathematics topics based on the placement of content in the chapters. However, teachers' lack of understanding in terms of the cognitive intentions of the curricular materials often contributes to an incoherent curricular use of the materials (Confrey, Gianopulous, McGowan, Shah, & Belcher, 2017). In addition, researchers have found that many teachers are using online materials to a greater extent and are often modifying their existing textbook sequences (Larson, 2016; Webel, Krupa, & McManus, 2015). The past president of NCTM, Matt Larson stated, ". . . [the] undercutting of curricular coherence by the introduction of disjointed tasks that are of questionable quality, do not fit within the mathematical learning progression and are not coherent" (Larson, 2016, p. x). While Larson specifically refers to online curricular selection, this stance can also be considered with regards to all tasks selected for instruction.

Building a coherent scope and sequence of mathematical topics is critical for developing students' understanding. As an example, students in Grade 8 should learn about rational and irrational numbers (CCSSM 8.NS.A1-2). These Grade 8 students also learn about the Pythagorean theorem; specifically, how to find a missing side length of a triangle and how to find distances between two points on a coordinate grid (CCSSM 8.G.B7-8). While these two topics are in different domains (number systems and geometry, respectively) they are naturally connected to each other: when students find the length of a missing side on a triangle they find rational or irrational numbers. Therefore, if students are to have opportunities to make connections between these two topics, they should be taught either together or in sequence with each other. Conversely, if teachers teach rational and irrational numbers in isolation from the Pythagorean Theorem, or from other content that may provide connections across content areas, students may miss a valuable opportunity to learn and to make important connections across the curriculum that has the potential to deepen their understanding of the content.

With the discretion to sequence topics given to local schools and districts, the question arises concerning the variance in arrangements of topics in a given grade level across schools. In this paper, we present data from eight Grade 8 teachers' scope and sequence documents across four states (AR, MI, NV, and UT) to answer the following research questions:

1) Where is the topic of geometric transformations sequenced within the Grade 8 curriculum across four states, and in what ways does the sequence allow Grade 8 students to make connections across mathematics content?

2) What influences Grade 8 teachers' decisions regarding the sequencing of the mathematics content?

Methods

Eight middle school teachers, from seven different school districts representing four states (AR, MI, NV, UT), were selected to participate in the study. The teachers submitted their scope and sequence documents and participated in an interview about the development of this document and rationale for their decisions related to the sequencing of Grade 8 mathematical content. These teachers participated in a larger National Science Foundation study focused on describing teachers' curricular reasoning for their mathematical decisions. All four states adopted CCSSM, and thus the content in Grade 8 was identical. We compared the scope and sequence documents submitted by the teachers to identify when content was taught during the academic year. We analyzed the interview data to identify the influences on teachers' decisions to sequence the content in the way they did. Finally, state assessment information from the four states was analyzed to triangulate the interview data and the scope and sequence documents.

Results

In this section, we present results as they pertain to the two research questions under investigation. In particular, we share our findings related to the sequencing of mathematics topics in Grade 8 that we identified through scope and sequence documents, as well as the teachers' thoughts gleaned from the interview data. Additionally, we discuss our investigation of the connections between scope and sequence documents and state assessment documents as an influencing factor for these decisions.

Scope and Sequence

In our NSF project, we primarily focused on examining teachers' curricular reasoning as it pertains to mathematical decisions related to the teaching of geometric transformations in Grade 8. Table 1 provides an overview of the reported scope and sequence of key topics per quarter (approximately 9 weeks) throughout the school year across the eight teachers. As reported in Table 1, two teachers taught geometric transformations during Quarter 1, one teacher each taught geometric transformations during Quarter 2 and Quarter 3, and four teachers taught geometric transformations during Quarter 4.

Table 1: Scope and Sequence of 8th Grade Content per Quarter

Teacher	Quarter 1	Quarter 2	Quarter 3	Quarter 4
AR_1 (HA)	**Geometric Transformations**	Linear Functions; Bivariate Data	Rational/Irrational Numbers; Pythagorean theorem; Angle/Triangle Relationships; Exponents	Solving Equations; Volume;System of Linear Equations; Congruence/ Similarity
AR_2 (MH)	**Geometric Transformations**	Angle/Triangle Relationships; Solving Equations; Congruence/ Similarity; Rational/ Irrational Numbers	Linear Functions; Solving Equations	System of Linear Equations; Pythagorean theorem; Volume; Bivariate Data
MI_1 (SJ)	Exponents; Rational/ Irrational Numbers; Pythagorean theorem; Solving Equations; Linear Functions	**Geometric Transformations**; Linear Functions; Systems of Linear Equations	Exponents; Volume; Angle/Triangle Relationships; Pythagorean Theorem	Bivariate Data
MI_2 (MT)	Rational/Irrational Numbers; Linear Equations; Linear Functions	Linear Equations; Bivariate Data; System of Linear Equations	**Geometric Transformations;** Exponents	Pythagorean theorem; Volume; Angle/Triangle Relationships
NV_{1*} (TC)	Rational/Irrational Numbers; Exponents	Solving Equations; Linear Equations; Systems of Linear Equations; Linear Functions	Angle/Triangle Relationships; Linear Functions; Bivariate Data	**Geometric Transformations;** Dilations; Pythagorean theorem; Volume
NV_{2*} (SS)	Rational/Irrational Numbers; Exponents	Solving Equations; Linear Equations; Systems of Linear Equations; Linear Functions	Angle/Triangle Relationships; Functions; Bivariate Data	**Geometric Transformations;** Dilations; Pythagorean theorem; Volume
UT_1 (BS)	Rational Numbers; Solving Equations; Exponents	Irrational Numbers; Exponents; Linear Functions; System of Linear Equations	Bivariate Data; Pythagorean theorem; Angles/Triangle Relationships	**Geometric Transformations;** Congruence/Similarity; Volume
UT_2 (FJ)	Solving Equations; Linear Equations	Linear Equations; Systems of Linear Equations; Bivariate Data, Linear Functions	Exponents; Volume	**Geometric Transformations;** Rational/Irrational Number; Pythagorean theorem; Congruence/ Similarity; Angle/Triangle Relationships

** Note: NV1 and NV2 are teachers at the same school.*

A similar variation of topic placement is evident across other content as well. In particular, the quarter in which teachers taught Bivariate Data, Congruence and Similarity, Rational and Irrational Numbers, Pythagorean Theorem, and Angle and Triangle Relationships (e.g., parallel lines cut by a transversal) is not consistent among the eight teachers. Furthermore, the placement of content relative to other concepts indicates that among these eight teachers in four states, there does not appear to be a consistent placement of topics throughout the school year.

Teachers' rationale for the placement of geometric transformations in the school year varied. We found that teachers who taught transformations in either quarter 3 or 4 were surprised when their students made connections to mathematics concepts they had taught earlier in the year, often without prompting from the teacher. One teacher (TC) was teaching Pythagorean triples when a student connected this idea to dilations. The student said, "well of course there are going to be other triples because you are just dilating the triangle so you just multiply the three sides of the triangle by a scale factor and you will have a similar triangle." As a result of students making these impromptu connections and once realized, the teacher decided to capitalize on this in the future. Another teacher (FJ) stated, "I would say that I would keep it [geometric transformations] at the end because I like tying everything together in a nice bow."

The two teachers who taught geometric transformations at the beginning of the school year (HA and MH) intended to make connections throughout the year. One teacher (HA) focused on the various connections she anticipated making instructionally throughout the school year. She added that Grade 7 students at her school can take an Accelerated Math course which would prepare them to take Algebra I in Grade 8. The Accelerated Math course included a unit on geometric transformations, so those students who discovered they were not ready for Algebra I in Grade 8 could transfer back into the regular Grade 8 Math course after the first quarter. Therefore, HA's reasoning for beginning the school year with geometric transformations was to ease the transition of these students back into the Grade 8 Math course without missing any new mathematical content during quarter 1 of the school year. The other teacher (MH) remarked that she intended to use geometric transformations (which was the focus for the entire first quarter of the year) as a springboard for the mathematics content taught throughout the year. While both teachers decided to teach geometric transformations as their first unit of the school year, their rationale for doing so was different. On the other hand, teacher (MT) who taught transformations in quarter 2 indicated that she had chosen to teach geometric transformations prior to the Thanksgiving break because it was a short unit, and the unit could be completed before the break. MT seemed not to consider curricular connections when placing the transformation unit and based her decision on the school calendar.

When directly asked how their scope and sequence documents were developed, the typical response from all eight teachers was that a group of teachers in a school or the district worked together to unpack the mathematics standards and then determine which mathematics content went together best. The teachers indicated that their knowledge of which content went together was largely based on their past experience as well as curriculum materials being used.

Influence of State Assessments on Scope and Sequence

Many of the teachers indicated that the content and timing of state assessments also impacted the placement and timing of the teaching of topics. In Table 2, we list the assessments used by each state. For example, the M-STEP (Michigan Student Test of Educational Progress) only assesses algebra topics in Grade 8, which the two teachers in our study indicated was a reason why they pushed the majority of geometry content to quarters 2 and 3. However, the Arkansas teachers taught transformations during quarter 1 and indicated that the state assessment impacted the placement of transformations in their scope and sequence. One teacher from Arkansas indicated that she believed the ACT Aspire was very geometry-intensive. This knowledge of the assessment also impacted her decision to teach geometric transformations during quarter 1.

In addition to conducting interviews centered on the scope and sequence document, we independently analyzed the assessment frameworks across the four states. We then compared teachers' scope and sequence documents to ascertain ways the state assessment might have influenced the placement of mathematics content. From our analysis of the official websites for each of the assessments, we identified several instances of misalignment between teacher's interpretation of the mathematics standards and the assessed content on the state assessment. For example,

Table 2: Assessments Used by State

State	Assessment
AR	ACT Aspire
MI	M-STEP (Michigan Student Test of Educational Progress) and MME (Michigan Merit Exam)
UT	SAGE (Student Assessment of Growth and Excellence) https://www.schools.utah.gov/assessment/assessments
NV	Smarter Balanced Assessment Consortium (SBAC)

Standard 8.G.A.3 asks students to "describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates" (CCSSI, 2010). Of the three states that assess geometry content, only the SAGE in Utah focused explicitly on assessing students' ability to provide coordinate rules for transformations, and the SBAC assessment used by Nevada explicitly notes that such rules are a "non-targeted construct" of the assessment. Yet all eight teachers in our study were explicit about the need to teach students the coordinate rules for transformations; they believed these rules were implied by the standard 8.G.A.3 and assessed on the state assessments.

Implications

From this study, we found that the same mathematical topics and concepts are taught among the eight teachers interviewed over the course of the year, which is not surprising given that each state included in the study adopted CCSSM. However, it is also apparent that among the teachers there is very little agreement regarding the sequence in which the content is taught across the school year. These discrepancies are understandable given that CCSSM does not dictate the ordering of content throughout the year. However, knowing that these discrepancies exist, we posit two areas of implications: implications for curriculum developers, district leaders, and state leaders, and implications for teachers.

Implications for Curriculum Developers and Leaders

We maintain that the sequencing of mathematics content matters for building connections of topics within the school year for students. From our small sample, we found that the scope and sequence documents were usually developed based on a small group of teachers' past experiences with different curricula and the sequences that were most familiar. This has implications for curriculum developers and district leaders. While we agree that there is no "right order" for mathematics content to be sequenced within a given year, there are sequences that naturally lead to connections more easily than other sequences that can unnecessarily make connections more challenging. We challenge curriculum developers to use learning trajectories research to determine sequences of mathematics topics in their curricula. While curriculum is typically sequenced to match the order of the chapters, we know that many teachers do not use curricula in this way. We suggest that curriculum developers could provide teachers with multiple sequences that could connect content in different meaningful ways.

While most districts have a scope and sequence document or framework, we suggest that the process for sharing and using the scope and sequence documents needs to be modified. In most districts this document is developed by a small committee of instructional leaders and teachers and then is disseminated to all teachers within the district. We believe that district leaders need to be more proactive and transparent in having discussions with teachers across the district about why topics are sequenced in the way they are and what connections are expected if the sequence is followed. These discussions could help teachers understand the connections that are expected across content rather than focusing on teaching a list of topics for assessments. We also believe that state and district leaders need to offer professional development for teachers to learn about different connections across mathematics content. Professional development needs to support teachers and their instruction with this knowledge. If state and district leaders were to discuss the reasons why content was sequenced as it is, then this may help teachers make decisions that would better support students making connections among the mathematics content taught.

Additionally, we found important differences among state-level assessments across the four states in our study resulting in disconnects between the curricular materials teachers use and their state assessments. That is, teachers are teaching topics (e.g., using coordinate rules for teaching transformations) while the state assessments explicitly labeled such topics as a "non-targeted construct." These discrepancies indicate that teachers likely need more exposure to the mathematical content of state assessment frameworks, and state-level coordinators need to build coherence between the content in state assessments and scope and sequence documents within schools or districts.

Implications for Teachers

The sequencing of mathematics within a grade and across grade levels is a vitally critical decision if teachers are to assist students in connecting mathematical content. We found in our study that teachers' decision-making for scope and sequence was primarily based on their current curriculum materials and personal experiences teaching the content. None of the eight teachers indicated that a learning trajectory was used to influence the sequencing of mathematics content in their classroom. Such lack of learning trajectory usage is an example of research in the field of mathematics education that is not reaching, nor directly impacting those who have the most influence on students' opportunity to learn – the mathematics teachers. We recognize teachers may need professional development focused on learning trajectories including why certain mathematical topics should be taught prior to other mathematical topics. In addition, in an era where traditional textbooks are not as prevalently used as in the past, and where many teachers are not using textbooks at all, all stakeholders (e.g., curriculum specialists, teachers, curriculum developers) need to consider the connections between different content when making sequencing and instructional decisions.

Furthermore, teachers need instructional support in sequencing curriculum that provides multiple learning opportunities for students to make mathematical connections. One consequence of the inconsistent curriculum sequence is that some students have many opportunities to connect mathematical concepts while others do not. For example, one of the teachers who started the school year teaching geometric transformations chose to do so because she saw many of the Grade 8 standards connecting to this idea (regardless of strands). She discussed that throughout the school year, she continued to build upon the "transformational thinking" from the first unit of the year within the subsequent topics, including integrating algebraic thinking and concepts into the geometry unit. Additionally, some of the teachers who taught geometric transformations later in the school year used this unit to connect multiple concepts together that had been addressed earlier in the school year.

Conversely, one teacher who began the school year with geometric transformations did not teach the concept of congruence and similarity until near the end of the school year. By placing these topics as bookends for the school year rather than in short proximity to one another, building connections between the two ideas would be harder to do. Hence students lost an opportunity to deepen their understanding of the connections between congruence and transformations. While we did not specifically look at the relationship between student achievement and specific curricular sequences, opportunities for rich mathematical connections are lost without a supporting sequence.

Conclusion

Although this is a limited study of eight teachers across four states, we have demonstrated that there is little agreement regarding the sequencing of content at one specific grade level. We assume that this phenomenon is not specific to Grade 8 or to the four states under investigation. Our study points to the incoherence among mathematics curriculum and confirms previous research indicating that among middle-grades curricular materials, there are important points of incoherence with the sequencing and development of topics (Olson, 2014).

Though the standards outlined in CCSSM are sequenced in multiple ways, sequencing must support student learning of the content and naturally build connections across topics. These curricular decisions regarding the placement of topics within the school year, as well as the duration of time spent on each topic, must be made with student learning in mind rather than for non-academic reasons that may pressure curricular decisions. Void of connections, students might believe that mathematics is simply an accumulation of topics and ideas. We maintain that the sequencing of topics within the school year is a vitally critical decision if teachers are to assist students in connecting the mathematical content. While we do not argue that there is one "right order" for the content to be sequenced,

we do suggest there are sequences that naturally lead to connections more easily made than other sequences.

In order to work toward meaningful mathematical education, we must ask how content is connected and not simply what content is taught. We believe that our field is at an important juncture in understanding that it is not enough to teach topics across disparate disconnected lessons. From our work, in particular from our current research couched within geometric transformations, it is necessary for teachers, district leaders, parents, and policy makers to understand that the more mathematical topics students are taught in disconnected lessons, the less opportunities they have to learn and be exposed to rich mathematics.

In our research, as well as our collective professional development work, we have observed teachers who are eager to deepen their understandings of mathematical connections and learning trajectories. We believe district leaders who design and deliver professional development to support teachers in deepening mathematical meanings need support to help school administrators recognize the importance of understanding these connections. In the end, we encourage all stakeholders who are involved in making curricular decisions for their school, district, or state to consider the importance and implications of sequencing mathematical content at the forefront of all decision-making and to do so with the goal of promoting connections and understanding across topics to deepen student learning. ✪

Acknowledgements

This research is based upon work supported by the National Science Foundation under Grant Nos. 1561542, 1561554, 1561569, 1561617. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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What Educational Leaders Need to Know About Early-Career Mathematics Teachers

James A. Martinez, *University of Tennessee*
Lisa R. Amick, *University of Kentucky*

Abstract

In response to a national crisis to retain middle and high school teachers in Science, Technology, Engineering and Mathematics (STEM) classrooms, a study was conducted to define factors that affect job satisfaction among early-career mathematics teachers, including perceived support by school administrators. Survey data gathered from 141 early-career mathematics teachers across the United States revealed the degree that administrative and peer support affected teachers' perceptions of their enthusiasm for teaching mathematics. Results from the study are being used to design targeted professional development involving early-career mathematics teachers with their principals with the overarching goal being to increase retention for these teachers in middle and high schools. Connections are made to promote professional development aimed at developing instructional leadership skills among school leaders.

Keywords

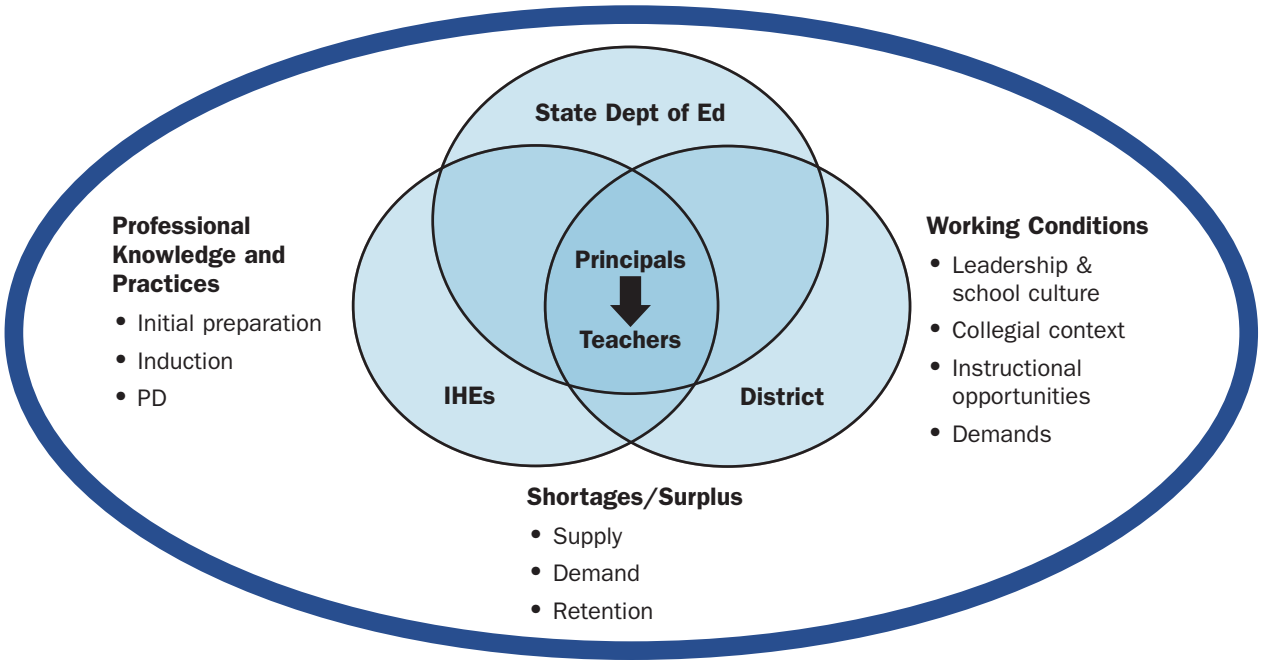
early-career, mathematics teacher, secondary, administrator support, principal

Introduction

Half of all teachers leave the profession within the first five years (Foster, 2010). This rate is even higher in high poverty schools and in subjects such as mathematics and science (Carver-Thomas & Darling-Hammond, 2017; Fantilli & McDougall, 2009; Goldring et al., 2014). Enrollment in teacher preparation programs is declining, and teacher turnover is costing America $7.3 billion annually (National Math + Science Initiative, 2013). Increasing percentages of less experienced mathematics teachers has a profound effect on how well-prepared students are in mathematics to be successful in high school, college and beyond. Researchers agree that addressing the mathematics teaching crisis meaningfully will require building a more cohesive system of teacher preparation, support, and development (Mehta, Theisen-Homer, Braslow, & Lopatin, 2015).

Providing additional support to early-career teachers by their site administrators is one strategy to address this need. For instance, the California Mathematics Project (CMP) emphasizes the importance of school leader support for mathematics teachers, stating in its guiding principles that "(mathematics) teachers need a variety of forms of support from exemplary…administrators…to facilitate their growth and development" (2012, p. 4). The CMP guiding principles inform teacher preparation in the California State University program, which "prepares more of California's P-12 teachers than all other institutions combined" (California State

FIGURE 1. *Conceptual Framework Describing Outside Influences on Early-Career Teachers (reproduced by permission of author)*



University, 2018). The purpose of this study is to investigate early-career, mathematics teacher perceptions of support in their schools and their general feelings of job satisfaction. This study contributes to a growing body of research by analyzing secondary mathematics teacher attitudes about administrative support using a quantitative research design with qualitative connections.

Conceptual Framework

To fully characterize the many outside influences that affect early-career teachers in their professional roles in their schools, we rely on a conceptual framework by Billingsley and Bettini (2017), represented in Figure 1. The figure was originally created to describe the factors and relationships of special education teachers, but it can be used more generally to characterize influences on early-career mathematics teachers.

At the center of these factors is the principal and the teacher, re-emphasizing the direct influence that the administrator has with early-career teachers. Both principals and teachers are affected by policies and directives put forward by the local school district as well as the State Department of Education. In addition, there are connections for early-career teachers to the institution of higher education (IHE) where they are currently matriculated in or have completed their preparation program. These "outside" organizations also interact with each other as well, in separate pairs or all as one, as shown in the diagram. For example, the State Department of Education may change teacher evaluation protocols which would need to be communicated (and ultimately adopted) by the school districts. IHE's and other professional development providers, like district offices, then would change their course requirements related to assessment of teachers to ensure they are prepared for the most current procedural expectations for evaluation at their sites.

As the framework illustrates, these dynamic interactions affect, and at times are affected by, the professional knowledge and practices, working conditions, and shortages/surplus aspects that are connected to staffing. For example, the increased demand for secondary mathematics teachers may allow for them to be hired as interns at their sites, which may alter the district's induction requirements for them, which in turn may provide alternative instructional opportunities for the newly hired teacher. It is important to note that "leadership" under the heading of "working conditions" refers to professional opportunities for teachers such as serving as a subject-area department chair (for larger schools) or leading a committee for accreditation. The elements described herein are enclosed within a large oval to emphasize the particular interactions which are

contained within the professional role and do not include outside influences (e.g. family, location) and individual teacher dispositions. Although significant, these outside forces were not addressed in this study except as they related to the early-career mathematics teachers' perceptions of overall job satisfaction.

Definition of Terms

Early-career teachers — those who are serving as the teacher of record while in their teacher preparation program (i.e. internship or residence model placements) as well as those who are serving as a contracted professional in their first, second, or third years in the classroom.

Review of the Literature

Administrative Involvement

The practicality and availability of school principals to support teachers has been a topic of focused research over the past half-decade. Carver-Thomas and Darling-Hammond stated that "given the enormous scope of their duties, it's simply unfeasible for principals to give the level of attention needed to supporting…teachers" (2013, p. 1). Particularly for hard-to-staff schools, research has shown that systemic structures (e.g. scheduling of professional development time, teacher compensation) served as barriers that kept principals from supporting teachers at their sites. Additionally, leadership skills (e.g. communication, self-care) were listed as traits that principals needed to develop to ensure that "principal-teacher relationships" were nurtured, forming a basis for collaboration (Hughes, Matt, & O'Reilly, 2015). Specifically addressing the role of principals in STEM schools, Sparapani & Calahan (2015) found that, of the factors that determined whether teachers regularly used technology in their science and mathematics classrooms, "the most important factor…is the involvement of the school principals" (p. 250-251). Faughn, Felter and Pence (2015) specified that support models for math teachers includes "professional development… (and) district and/or school administrative support among others" (p. 1614).

In a quantitative study specifically focused on secondary teachers, You and Conley (2014) analyzed National Center for Educational Statistics (NCES) School and Staffing Survey (SASS) responses from over seventeen thousand U.S. teachers. The data from this investigation revealed a statistically significant correlation between administrative support and teacher work commitment for novice (five years or less), mid-career (six to ten years) and veteran (more than 11 years) teachers. Furthermore, the effect administrators have had on teacher job satisfaction has been documented with teachers who served in STEM classrooms in the mid-1990s and early 2000s. For example, Walker, Garton and Kitchel (2004) surveyed 149 secondary science (i.e. agriculture) teachers in Missouri who left the teaching profession during this period. In qualitative (open response) measures, "lack of administrative support" (or statements to that affect) were the most frequently cited reasons for their departure from the profession. In another analysis of quantitative measures, the Learning Policy Institute ranked lack of administrative support among the most frequently cited reasons for teacher departure in 2012-2013 (Carver-Thomas & Darling-Hammond, 2017).

Classroom Management Support

The relationship between classroom management issues and teacher attrition has been well-documented. Wentzell & Cohn (2017) presented their understandings about early-career teacher attrition stating that the "most common reasons teachers cite for leaving the profession include lack of support from administration/ineffective school leaders, feelings of isolation, a sense of powerlessness in the decision-making process, lack of effective classroom management skills, working in subpar conditions, and lack of peer support" (p.47).

In their review of related literature, Guarino, Santibanez, & Daley (2006) collected research articles which focused on teacher recruitment and retention, specifically those which examined the characteristics of those teachers who left the teaching profession. Generally characterizing the collected studies, the authors stated that "the most frequently reported causes of job dissatisfaction both for migrating teachers and teachers who left the profession were low salaries, lack of support from the school administration, and student discipline problems" (p. 51). Ingersoll (1999) examined characteristics of schools which affected staffing, including reasons for dissatisfaction among teachers that led to increased migration. In agreement with the above studies, "low salaries, lack of support from the school administration, student discipline problems, and lack of teacher influence over decision-making" were listed as significant factors affecting job satisfaction for teachers (p. 22).

Instructional Support

With the increased emphasis on judging school effectiveness based on standardized testing results, site principals are encouraged to practice instructional leadership (IL) as part of their duties. Prior to the 1980s, the role of a school administrator was focused on managerial tasks with less of an emphasis on curriculum and instruction. Improvement of instructional practices by teachers was addressed by other professional educators who were separated from the line authority of the principal (Alfonso, Firth, & Neville, 1975; Hoy & Forsyth, 1985). The concept of a principal as an instructional leader was introduced in the 1980s and redefined their role as facilitators of professional development and of good teaching in the classroom (Beck & Murphy, 1993). Brazer and Bauer (2013) state that instructional leadership is "the effort to improve teaching and learning for PK-12 students by managing effectively, addressing the challenges of diversity, guiding teacher learning, and fostering organizational learning" (p. 650).

Principals take the lead in building strong teams of teachers who are directly charged with improving student outcomes (Zepeda, 2014). In support of the importance of IL, Elmore (2004) posits, "the skills and knowledge that matter in leadership . . . are those that can be connected to, or lead directly to, the improvement of instruction and student performance. Under this definition, principals' core work is instructional improvement, and everything else is instrumental to it" (p. 58). In a meta-narrative review of 109 quantitative studies published between 1985 and 2013, Boyce and Bowers (2018) found that "principal leadership and influence" was one of four emergent themes of instructional leadership and that "teacher retention" was one of three factors most researched in connection to instructional leadership. By practicing IL, principals build the capacity of teachers to ensure instructional improvements are sustained (Honig, Copland, Lorton, Rainey, & Newton, 2010).

Grissom, Loeb and Master (2012) endorse effective instructional leadership by stating "time spent coaching teachers about their instructional practice and evaluating teachers or curriculum predict greater school effectiveness and increases in school effectiveness (than overall instructional time)" (p. 4). Particularly with regard to supporting school administrators as instructional leaders in mathematics, Boston, Henrick, Gibbons, Berebitsky, & Colby (2017) argue that "an essential component of knowledge and skill required by principals is the ability to differentiate between high- and low-quality instruction within a specific content area" (p. 184). This would require that some administrators acknowledge a departure from previously accepted forms of mathematics instruction (e.g. direct instruction with student note-taking and individually solving problems by applying algorithms) to more current instructional practices endorsed by the National Council of Teachers of Mathematics (NCTM). For example, principals practicing IL would advocate that their mathematics teachers employ whole-class, active student discussions where students use reasoning skills to justify alternative methods to solve problems (Boston et al., 2017).

Methods

Under the auspices of the Association of Public Land-grant University (APLU) Mathematics Teacher Education Partnership (MTEP), two online surveys were used to better understand the degree to which early-career mathematics teachers felt they were being supported in their schools. The following sections will focus on the procedures, participants, methods and data analysis related to this survey research.

Procedure

An online pilot survey containing 23 quantitative and qualitative questions was developed in the fall of 2015 by an MTEP working group of secondary mathematics teachers and school administrators, as well as higher education faculty who specialize in mathematics, mathematics education and educational leadership. An electronic mail was sent to all MTEP institutions across the United States which included secondary mathematics teacher preparation programs with an appeal to forward the survey to early-career teachers who were matriculated or had earned their teaching licensure through their programs. In all, 47 early-career teachers responded to the pilot survey in the spring of 2016. The researchers reduced the data from the pilot survey creating graphical representations that were presented to the entire MTEP working group at the MTEP annual conference in the summer of 2016.

A representative group of seven MTEP educators met in October of 2016 to analyze the results from the pilot survey to create a final survey. This final survey, comprised of 25 questions, was sent out in November of 2016 to all MTEP institutions in the same manner as the pilot survey, ultimately resulting in 141 early-career teacher responses. The following sections detail the participants, measures,

data analysis, results, and conclusions drawn from the final survey.

Participants

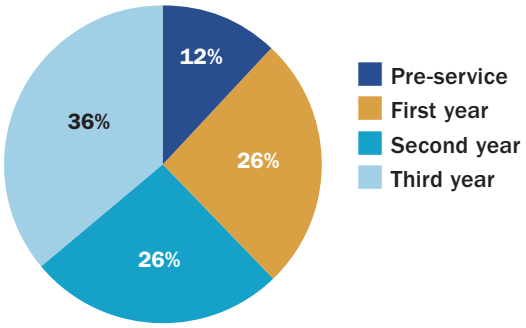
A third of the participants who responded to the final survey were located in the state of Utah, USA. However, data were gathered from participants from a number of other states as well as shown in Table 1.

The pre-service and early-career teacher participants were solicited via electronic means by MTEP university faculty. As shown in Figure 2, twelve percent of the respondents designated themselves as pre-service teachers, 26% in their first year, 26% in their second year and 36% in their third year of teaching. An overwhelming number (94%) of these teachers were serving in public secondary schools. Of all participants, sixty-eight percent of survey respondents described their communities. They described them as rural (13%), suburban (32%), and urban (23%), teaching in a full range of classes from 6th grade general math through calculus. Although the majority of the teachers participating in the study were serving students in middle income neighborhoods, many also taught in low-SES (26%) and high-SES (9%) schools. Almost three-quarters (72%) of the pre-service and early- career teachers surveyed stated that between five and twenty percent of the students they were teaching had Individual Educational Plans (IEPs). Fifty-nine percent stated that between five and twenty percent of their students were designated as English Language Learners (ELLs), and fifty-five percent of them reported that between forty to one hundred percent of their students qualified for free and/or reduced lunch.

Table 1: Final Survey Participants by State

State	Participants	Percent of All Participants
Utah	47	33
Texas	27	19
Tennessee	17	12
California	9	6
South Dakota	9	6
Nebraska	6	4
Georgia	5	4
Hawaii	5	4
Kentucky	4	3
North Dakota	4	3
Minnesota	2	1
Idaho	1	1
Illinois	1	1
New Jersey	1	1
Washington	1	1
Wisconsin	1	1
Wyoming	1	1

FIGURE 2. *Participants by Experience Level*



One survey question that related to overall job satisfaction prompted the early-career mathematics teachers to respond to the query, "To what extent do you agree with the following statement: I am generally satisfied with being a teacher, student teacher, or observer at this school". Likert-type responses from this question were: (a) strongly agree, (b) somewhat agree, (c) somewhat disagree, and (d) strongly disagree. Ninety-three percent (n=131) either strongly agreed or somewhat agreed to this question, which vastly contradicts the fact that about half of all teachers leave the field in their first few years. Researchers believe this may have occurred because those teachers who are enjoying their jobs are possibly the same ones who are willing to take the time to fill out a survey to inform the field of education as a whole. Since, generally speaking, the teachers responding to the survey were content with their professional role, results from other survey questions need to be grounded with this understanding. That is, responses to their feelings about administrative support and how this support relates to their enthusiasm for teaching were taken from early-career teachers who, for the most part, had an

optimistic attitude about their professional roles. While this population is not necessarily representative of early-career teachers as a whole, researchers believe that this unique group of highly satisfied teachers can provide much insight on what needs to be present for early-career teachers to have high levels of job satisfaction.

Measures

Surveys used for this study were created in the Qualtrics® survey software which ultimately gathered both quantitative (e.g. Likert scale) and qualitative (e.g. open-response) data. For the quantitative portion, Likert scale questions did not include a neutral selection option as it was important to have the respondents either agree or disagree, to some degree, to these queries (Fink, 2003; Fowler, Jr., 2014). Data collected in the surveys revealed teachers' feelings about: (a) professional development activities, (b) professional learning communities (PLCs), and (c) perceived level of support by on- and off-site administrators. Demographic information was collected also. Detailed contextual information about the respondents' schools (e.g. public, private, middle school, high school) was collected as well as the degree that these teachers served students from special populations (i.e. special education, English Language Learner, gifted). More specifically, the degree that the participants generally felt that their administrators supported them professionally was measured, as well as how this support was confined to specific areas (e.g. assessment, instruction, curriculum, classroom management, collegial collaboration and course assignments/loads).

Delimitations and Limitations

This study is limited primarily due to the relatively small number of participants in 17 U.S. states, so results cannot be generalized to larger, broader populations. In addition, the convenience selection of these participants biased the results as participating teachers were serving in MTEP sites, and therefore, the sample is not representative of all secondary, early-career mathematics teachers. Inherently, survey responses and self-reported data are limited by individual perceptions of reality. In addition, survey research does not manipulate the conditions in an experimental manner (e.g. treatments and controls) and therefore cannot infer cause and effect. The analysis of the quantitative data in this study was descriptive in nature and as such does not infer statistical inference or significance.

Data Analysis

The descriptions of data reduction that follow were used for both the pilot and final surveys. As an initial step, electronic survey data collected from the Qualtrics® survey software was imported into the Microsoft® Excel software program. Once the transfer of data was complete, representations of the data (e.g. pie/bar/column charts) were produced so the researchers could view the data graphically. Numerical quantities for each measure were included in the graphical representations. Geographic data were exported to the online site, EasyMapMaker.com, to create visual representations of this data. Qualitative data acquired from the Qualtrics® survey's open-response questions were exported into the Microsoft® Word software program, where a preliminary exploratory analysis was performed by the researchers. Qualitative statements from the participants that supported quantitative measures were separated for use in reporting.

Results

So what do educational leaders need to know about early-career mathematics teachers? One of the most important findings is that this unique group of satisfied teachers feel a strong sense of connection and support. Researchers on this project believe that if we can better understand these supports, strengthen them even further, and replicate them for teachers with presumably lower levels of support and job satisfaction, then we can truly impact the teacher retention crisis that is happening in our country. The first step in that process is to better understand how the teachers in this study are being supported. Analysis of data revealed the extent that the early-career teachers perceived themselves as receiving administrative support including the types of assistance that were most meaningful to them.

Degree of Support by Different Administrators

One survey item prompted the early-career teachers to respond to the question, "How much support do you receive from the following (administrative persons)?" and were provided the following options: (a) substantial support, (b) moderate support, (c) minimal support, (d) no support, or (e) does not apply. The survey collected these responses from the teachers as they regarded support from: (a) the superintendent, (b) other district office administrators, (c) the principal, (d) other building administrators, including associate or assistant principals, deans, and the like, and (e) university professors. Table 2 displays these results.

Table 2: Participant Responses to "How much support do you receive from the following (administrative persons)?" (n=141)

Administrator	No Support	Minimal Support	Moderate Support	Substantial Support	Does Not Apply
Superintendent	45	40	12	5	38
Other District Office Administrators	27	37	37	8	32
Principal	5	28	44	51	13
Other Building Administrator (Associate Principal, Assistant Principal, Dean, etc.)	4	25	42	57	13
University Professor	32	20	25	20	44

In terms of a combined measure of moderate and substantial support, principals (n=95; 67%) and "other building administrators" (n=99; 70%) far outpaced other persons under consideration. Moderate and substantial support from other district office administrators (e.g. instructional coordinators or teachers on special assignment) and university professors was considerable (n=45; 32%). For this measure, the least amount of combined responses for moderate or substantial support (n=17; 12%) were associated with the superintendent.

Specific Areas of Support

Study participants were also asked to rate the support by the aforementioned persons in particular areas including: (a) curriculum, (b) classroom management, (c) course alignment/load, (d) assessment, (e) instruction/instructional materials, (f) collegial collaboration, and (g) affirmation. Table 3 displays these results.

Although all the persons listed gained votes in each of the categories by the participating teachers, site principals

Table 3: Participant Responses to "In what areas do you receive support from these administrators/ university partners? (Select all that apply.)?" (n=141)

Administrator	Curriculum	Classroom Mgmt.	Course Assignment/Load	Assessment	Instruction/ Materials	Collegial Collaboration	Affirmation	N/A
Superintendent	6	5	4	3	2	2	30	91
District Office Administrators	54	16	6	28	37	15	24	58
Principal	24	52	39	25	27	33	85	23
Assistant Principal	20	68	25	31	30	34	67	36
Dean	2	5	2	3	1	1	4	123
University Professor	30	26	14	24	29	27	25	88
Other	20	15	8	17	18	11	13	70

were chosen most often overall, including garnering the highest number in affirmation and course assignment/load. The assistant principal ranked second overall, leading the collegial collaboration, assessment, and classroom management categories. District office administrators and university professors ranked third and fourth, respectively, with district office administrators leading the curriculum and instruction/instructional materials categories. Associate principals ranked fifth overall, then "other", and finally the superintendent, ranked seventh, and dean ranked eighth, overall. In terms of support from administrators in a variety of areas (curriculum, classroom management, course assignments, assessment, instruction, collaboration and affirmation), the respondents relied to a much larger degree on those who were on-site (principals and assistant principals) rather than university professors and district office personnel.

Meaningful Support

In a related open-response question, "Please describe the most meaningful, mathematics teaching-related support that you received from an administrator and why it was meaningful for you," study participants provided qualitative responses that revealed the degree that study participants felt administrators supported them with content. In terms of support from off-site administrators, one early-career stated, "I have received very little support from (on-site) administration. The only teaching-related contact I have had with an administrator has come from the director of curriculum who evaluated me for PDAS (Professional Development and Appraisal System)." In terms of administrators at their school sites, a number of teachers responded to this question with a connection to their administrators' supervisory practices (e.g. evaluation, observation). One teacher commented, "I received positive feedback on my observations and they appreciated my effort to engage students and come up with activities to help students meet objectives." Another noted, "The principal is my evaluator this year and we have honest conversations on how I am as a teacher. I am still learning new things each year and he lets me know areas I can focus so that it is not overwhelming." One other participant responded by saying, "The principal had a walkthrough and coached me on questioning techniques. It was very helpful in teaching effectively." And finally, one other early-career teacher shared that "Administrators have been happy to observe my class and offer feedback whenever I have requested it." Overall, these positive statements could be summed up by one teacher's comments:

> My principal was my evaluator for my first year. He was very supportive and encouraged me to try new things. He praised the way I ran my classroom and used assessments and gave me lots of encouragement that I needed as a first year teacher. Since then, I have felt very comfortable going to him with questions, concerns, and struggles that I need advice for.

That said, a number of teachers were critical of the support, or lack of, provided by their administrators as it relates to mathematics teaching. One participant stated, "Administrators do not really support me in a mathematics teaching-related context. The administrators that I work with are concerned with scores on district Proficiency assessments and EOC (end of course) scores." Another remarked, "I cannot recall any mathematics teaching-related support that I have recently received form [sic] an administrator." One other study participant responded, "My mentor teacher and I had a quick meeting with the Principal about how things were going…not necessarily mathematics teaching-related but teaching related." Another noted, "I have not yet received any support from my administration that was specifically mathematics teaching-related."

Content Related Support

However, a few teachers answered the survey question about "mathematics teaching-related support" by their administrators by alluding to their principal's comfort level with the subject. One study participant felt that content-related support was not essential to her success, stating:

> I would say my assistant principal. While they weren't [sic] a math person, they were able to give me some direct instruction on how to deliver the material better. Simply listening to my instruction, he was able to let me know what was unclear for him, from a student's perspective, and how I could have done it differently that might have allowed him to understand.

That said, a few teachers responded positively regarding their administrators' background knowledge and support with regard to content. For example, one noted, "My admin was a previous math teacher so I can seek advice on anything," and another stated, "One of the assistant principals used to be a math teacher and has been very supportive. She is knowledgeable in the material and was a great teacher. She has observed me multiple times with helpful feedback." Finally, one teacher spoke of assistance with a

particular mathematical/pedagogical skill, stating that, "the associate principal gave us ideas of different ways to teach slope and engage the students."

A few early-career teachers responded to this question about the "most meaningful, mathematics teaching-related support" by relating to their principals use of general encouragement. For example, one noted, "My administrative support doesn't relate to teaching or pedagogy. Most of the support I receive is encouragement." Another stated, "I received general support from the principal and assistant principals, which I would characterize as general positive encouragement of the sort directed to all teachers at the school." One other responded by stating, "Our assistant principal has been extremely helpful…He is always checking in to see how things are going…I feel very comfortable asking for help from him and our other administrators whenever I need it." In a tribute to non-content related support, one other early-career teacher responded:

> I haven't really received direct support with mathematics instruction from administration as far as content goes. I have, however, received major support regarding parents that call in with issues. I found this meaningful because it reassured me that I was doing my job correctly and fairly. It reassured me that I had support from the "higher-ups" that could reassure parents that I am performing to a standard that the school and district expected and approved of.

Classroom Management Support

This comment was echoed by a few other participants who voiced their praise for their administrators with regard to classroom management and parent issues. One teacher related, "My assistant principal is the most meaningful supporter because she helps me through…behavioral issues." A related story from another early-career teacher further illustrates this point:

> My assistant principal recently helped me with a parent/student/grade issue. The student was not performing well in my class. The student had a B in my class for the first quarter I taught them and then their grade dropped dramatically when their grandparent passed away, understandably. However, with only three weeks remaining in the course the parents started to constantly email and call me asking if there was any way their child could get a B in the course. My assistant principal helped me handle the constant calls and e-mails as well as reinforced what I was saying.

Professional Learning Activities that Increased Enthusiasm

With regard to professional learning activities that had occurred within five months of taking the survey which marked an "increase (in the study participant) enthusiasm for teaching mathematics," a number of possibilities were included in the survey for consideration, including: (a) professional conference, (b) professional development workshop, (c) work/communication with a mentor/coach, (d) work/communication with an online professional community, (e) professional course (e.g. online/university), (f) coordination/planning with site/district colleagues, (g) school/department meetings, and (g) online activities. The teachers ranked each category as "very influential," "moderately influential," "not influential," or "I did not participate in this activity." Table 4 displays the results of this survey question.

In terms of a combined measure of "very" or "moderately" influential, "work/communication with a mentor or coach" rated the highest among all choices with 84% (n=119) of the respondents. Although the "mentor/coach" in this question was not specified, the result exemplifies the level of support that these early-career mathematics teachers have with this form of collaboration.

Professional Decisions

As the results of survey research cannot be used to infer cause and effect, it was not the intent of this study to determine how support from administrators, other professionals or professional organizations, and professional development affected these teachers' feelings about whether teaching was the best personal choice for them, in terms of career. That said, the survey included a question that asked these teachers "if (they) could go back and start college again," would they: (a) "certainly…not become a teacher," (b) "probably…not become a teacher," (c) "certainly… become a teacher," or (d) "probably…become a teacher." One additional option allowed these teachers to state that they were "unsure (they) would become a teacher." Table 5 displays the results of this survey question.

Overwhelmingly, the early-career mathematics teachers responded they would either "certainly would become a teacher" or "probably would become a teacher" (81%, n=114). Eleven percent (n=14) stated they were "unsure (they) would become a teacher," 5% (n=7) responded that they "probably would not become a teacher," and 3% (n=4) responded that they "certainly would not become a

Table 4: Participant Responses to "To what degree did each set of professional learning activities you participated in during the last five months increase your enthusiasm for teaching mathematics?" (n=141)

Professional Learning Activity	Did Not Participate	Not Influential	Moderately Influential	Very Influential
Professional conference	83	7	29	24
Professional development workshop	21	30	71	22
Work/Communication with a mentor/coach	10	15	68	51
Work/Communication with online professional community	93	17	26	7
Professional course	81	12	25	23
Collaboration/planning with site/district colleagues	33	21	60	28
School/Department meetings	12	44	65	19
Online	92	18	23	10

teacher." In terms of longevity in the profession, nearly half (46%, n=65) of the surveyed early-career teachers would remain in teaching "as long as (they) were able."

Qualitative responses to the question, "If I could change one thing about my job, it would be..." yielded a variety of responses. Support with classroom management was mentioned most frequently. For example, one teacher commented that they would appreciate having, "more support from administration and better classroom management strategies." Another stated, "administration [sic] support with trouble students" and another responded to this question with "more support, especially in the discipline area."

Collaboration and curricular modifications were also mentioned in response to this question. One early-career teacher stated she wanted additional, "support and collaboration within our high school community…more time to meet with other teachers and our administration" and another requested a "more student accessible curriculum."

Summary of Results

What are the biggest takeaways from these results? What do educational leaders need to pull from this study in order to better support their early-career mathematics teachers in hopes of retaining them in the field?

Table 5: Participant Responses to "If you could go back and start college over again, would you still choose to become a teacher?" (N = 141)

Survey Response Choice	n	Percentage
Certainly would become a teacher	53	41
Probably would become a teacher	61	47
Unsure I would become a teacher	15	12
Probably would not become a teacher	7	5
Certainly would not become a teacher	5	4

1. Simply put, teachers in the study wanted backing and praise from their administrators. Teaching requires commitment and perseverance – words of encouragement from an administrator are substantive and reaffirming. A great deal of current research focuses on the importance of administrators serving as instructional leaders, but the teachers in this study value different types of support in their school settings, including support for their professional judgement and being "backed up" in their decision making with students and parents.

2. Early-career teachers crave one-on-one, personal professional development experiences at their school sites that are meaningful and impactful. Even in a technology driven society, teachers participating in this study were not finding substantial support through online resources or virtual relationships. Administrators should create and support on-site, personal, authentic mentor/mentee relationships that are vital to the success of early-career teachers.

3. This study shows that early-career teachers are not using administrators as substantive sources of support for instruction, curriculum, and assessment. Because principals are often responsible for teacher evaluations, and because the more support early-career teachers have, the higher their job satisfaction, principals should have adequate mathematical content knowledge to understand and appreciate best practice teaching strategies in mathematics.

Discussion/Implications

While this specific study focuses on the current support systems of early-career secondary mathematics teachers and the role of educational leaders in those support systems, the overarching goal of the work is to impact teacher retention by better understanding successful support systems and replicating them. The role of administrators is often said to be that of an "instructional leader" in the school, but this study argues that other forms of support may be of equal, if not more, importance to early-career teachers.

Aside from general mentoring and coaching, the perceptions of effective modes of administrator support varied widely by early-career teachers participating in this study. With regard to individual support, principals and "other (on-site) building administrators" far outpaced off-site administrators under consideration. Additionally, quantitative measures showed that support by principals and assistant principals was perceived as more substantive by the study participants in certain areas – affirmation, course assignment/load, collaboration, assessment and classroom management. Qualitative analysis revealed that the early-career teachers in the study appreciated administrative support with general encouragement and challenging parent interactions.

The degree that a variety of professional learning activities increased participant enthusiasm for teaching revealed that "work/communication with a mentor or coach" was most highly valued, followed by "school/department meetings" and "collaboration/planning with site/district colleagues." This result relates to the need by these early-career teachers to connect in authentic ways with other professionals as opposed to more traditional professional development opportunities (e.g. professional conferences/workshops/courses) and, surprisingly, computer-based activities (e.g. online professional communities). The results also imply that school districts which have limited collaborative professional development opportunities would benefit from instituting formalized modes of collaboration for early-career teachers, whether that includes the hiring of dedicated instructional professionals (e.g. subject coaches) or increasing subject-specific, collaborative time.

When the early-career teachers in the study were asked to gauge the degree to which they felt they had made the right choice in choosing teaching as a career, over four-fifths of responded that they would probably or certainly become a teacher and nearly half responded that they would remain in teaching "as long as they were able."

Responses from this study's early-career teachers suggest that increased attention by administrators, especially those with limited mathematical backgrounds/experiences, on effective ways that mathematical content is delivered, would improve these teachers' perceptions of administrative support at their schools. In response, due to more recent changes in research-based, best practices for teaching mathematics, targeted professional development for these administrators is warranted that effectively outlines these updated practices. In addition, to ensure that early-career mathematics teachers are effectively evaluated, administrators need to readily recognize effective pedagogical practices in mathematics (Boston et al., 2017).

We feel that advanced preparation for administrators better prepares them to recognize and appreciate currently-endorsed teaching practices (e.g. discourse, modeling, collaboration) over more rudimentary practices (e.g. reduced noise level in the classroom, number of times a student/group is called upon to answer a question). Furthermore, we feel that advance preparations adopted by supervising administrators to assist them in more fully understanding mathematical concepts (e.g. watching a brief overview video on the topic developed) prior to entering classrooms for informal and formal evaluations, would substantively increase the value of these evaluations for both the administrator and the teachers. Measures such as these would also support administrator instructional leadership qualities as administrators make connections between theory and practice (Freedberg & Rice, 2014). Not only would strengthening the mathematics content and pedagogy knowledge of local administrators help mathematics teachers get more accurate evaluations, it would also provide early-career teachers with another layer of support (instructional) that they currently are not receiving as evidenced by the teachers in our study.

Recommendations for further study include additional analyses of survey data collected in this study, including aggregating data by teacher years of experience, teaching level (i.e. middle school, high school), geographic area (i.e. urban, suburban, rural), primary subject(s) taught (e.g. Geometry), and school demographics (e.g. socioeconomic income, percent of special education students). Additionally, since the qualitative data in this study was only used to support the quantitative results, a separate coding of open-ended survey responses to produce meaningful themes is warranted. Finally, investigating the degree that content-specific professional development for administrators affects teacher perceptions of support is recommended. ✪

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   - Engaging the attention and support of other education stakeholders, and business and government, in order to broaden as well as to strengthen mathematics education leadership.

3. Manuscripts should fit the categories defining the design of the journal.

   - Case studies of mathematics education leadership work in schools and districts or at the state level and the lessons learned from this work
   - Research reports with implications for mathematics education leaders
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4. Manuscripts should be consistent with the NCTM Principles and Standards and should be relevant to NCSM members. In particular, manuscripts should make the implications of its content on leadership practice clear to mathematics leaders.

5. Manuscripts are reviewed by at least two volunteer reviewers and a member of the editorial panel. Reviewers are chosen on the basis of the expertise related to the content of the manuscript and are asked to evaluate the merits of the manuscripts according to the guidelines listed above in order to make one of the following recommendations:

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* Please contact the journal editor if you are interested in becoming a reviewer for the *Journal*.

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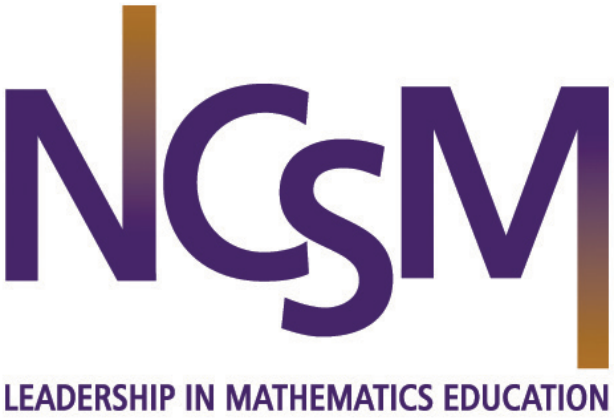

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