

**A SITUATED PERSPECTIVE OF RURAL SECONDARY MATHEMATICS
TEACHERS DILEMMAS AND RESOURCES**

A Dissertation Presented for the
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Degree
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DEDICATION

To my mother
Cynthia Lynne Calloway Lawson

To my father
Gary Michael Lawson

To my step-mother and sister
Lori and Elle Lawson

To my furry friend
DJ

I love you 3000.
This is for *you*.

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To my mentor, advisor, and committee chair, Dr. Lynn Liao Hodge: Thank you. Thank you. Thank you. You are a steady current in the chaos that is life. You believe in me when I struggle to do so for myself. You have provided me with countless opportunities to grow as an academic and human-being. I look to you as an example of what it means to be a purposeful and empathetic person. Without you this dissertation would not have been possible, and I would not be in the position I am today.

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ABSTRACT

The purpose of this study to understand how teachers in rural southeastern United States conceptualize and make use of resources to manage the dilemmas they experience. This is a response to a lack of focus on the rural context in educational research, making it a, “pragmatic necessity and empirical imperative to understand the individuals who teach in these districts” (Burton et al., 2013), and to an understudied area in mathematics education research—resources. Thus, this study adds to the literature by taking a situated perspective to study the following research question and sub questions: (RQ) *How do mathematics teachers in rural settings make use of resources to mediate dilemmas in practice?*; (SQ1) From the teachers’ perspective, what are the dilemmas of practice that mathematics teachers in a rural setting experience?; (SQ2) How do mathematics teachers in rural settings conceptualize resources for the teaching and learning of mathematics?

To explore the research question and sub-questions, tenants of an instrumental qualitative case study (Stake, 1995) were used explore a sample of five rural secondary mathematics teachers (RSMT) dilemmas and resources in-context-in-practice. For each participant, data were collected over a two-month period and include two interviews, one classroom observation, and teachers’ completion of three resource diaries (structured reflections about planning and teaching a mathematics lesson). Analysis from this study shed light on the RSMTs perspective of resources for the teaching and learning of mathematics and bring focus to the mediating role resources with respect to dilemmas they experience. Across the RSMTs resources were categorized as school materials, curriculum materials, other teachers, experience, and students, and dilemmas were identified within the dilemma of ambitious teaching, the dilemma of curriculum

materials, and the dilemma of control. In mediating dilemmas, the internet, teaching and professional experiences, and other teachers act as primary resources the RSMTs utilized, and, though present, some structures (e.g., professional learning communities) are not being properly implemented to support teachers' dilemma management. Directions for future research and theoretical and practical implications are also discussed.

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CHAPTER ONE

INTRODUCTION

Teaching is a complex endeavor. However, messages conveyed by the media and general public portray teaching as procedural and non-intellectual (Bates, 2014; Bradshaw, 2014; Broudy, 1956). This portrayal simplifies the work of teaching and describes teachers as “technical-production managers... as cognitive information processors, as implementers of researchers’ knowledge about how to produce learning” (Lampert, 1985, p. 191-192). This view of teaching and teachers has permeated national educational discourse and become somewhat of a norm in the current accountability movement. Bates (2014) comments that the accountability movement has led to a “devaluing of the intellectual rigor of teaching,” where teachers are removed from the curriculum and instructional design and asked to take direction, implement it, and ask no questions (p. 3).

The development of educational theory and philosophy has put forth a more insightful understanding of the complex nature of teachers’ work and the dynamic knowledge necessary for highly effective teaching (e.g., Bates, 2014; Bradshaw, 2014; Broudy, 1956; Clandinin & Connelly, 1996; Koehler, Mishra, & Cain, 2013; Schoenfeld, 1986). With the development of educational theory, many have rejected a simplified view of teaching and embraced a more nuanced view that takes into consideration teachers’ active role in moment-to-moment decision making about what and how to teach (Ball, Lubienski, & Mewborn, 2001; Davis, Palincsar, Smith, Arias, & Kademain, 2017; Hill et al., 2008; Lampert 1985; Schoenfeld, 2014; Sullivan & Mousley, 2001).

The increased focus on teachers' knowledge and decision making has produced insights that illuminate the tensions teachers experience in their work and provided a better understanding of the complex nature of teaching in relation to theory, research, and practice. An example of this is the work of Herbst (2003). In his work, Herbst uses tensions as a part of the framework used for his interpretation of one teacher's work eliciting new ideas that emerge from students' work on a novel mathematics task. Specifically, Herbst explores the following three tensions: where to direct students' activity, how to represent mathematical objects, and how to elicit students' conceptual actions that are instrumental for the task. The three tensions provide a means to uncover the nuanced decision making (i.e., management and negotiation) that teachers experience in their actual work with student thinking and development of student knowledge. Though making no empirical claim about the use of novel tasks, an initial takeaway is that Herbst's work highlights the fruitfulness of tensions as a theoretical construct to understand teachers' work. A second takeaway is that novel tasks are implemented in context and should be considered with a broader understanding of the teacher and student interactions with the task and each other. As Herbst describes it, "A mathematics teacher and his or her class create an original mathematic performance as their interactions unfold in context" (Herbst, 2003, p. 231).

A second example of the use of tensions in mathematics education literature is Gutierrez (2009), who reflects on her time preparing teachers to think about issues of equity (e.g., identity and power) in relation to tensions that come with knowing students, managing classrooms, and teaching 'mathematics'. In her work with preservice teachers, Gutierrez uses these tensions to foreground the complex nature of teaching mathematics

and couples these tensions with an equity lens to highlight the broader impact teachers have on students. This understanding and view of teaching allows mathematics teachers the flexibility to teach effectively at any place or point in time. For Gutierrez, it is the development of one's orientation towards mathematics teaching and learning that best prepares teachers to make decisions and embrace the complexities of teaching. The work of Gutierrez shows that by having a greater understanding of one's orientation, mathematics teachers are better prepared to embrace the inherent tensions that arise in their work and make effective and equitable decision in the course of teaching. The works of Herbst (2003) and Gutierrez (2009) show the complexity of mathematics teaching and the benefits of viewing instructional practice through the tensions that teachers experience across place and time.

Understanding mathematics teaching as a complex and nuanced activity has better equipped mathematics teacher educators and researchers to understand the contextualized realities of mathematics teaching and learning and support prospective and in-service teacher development. In particular, mathematics teacher educators have found ways to better prepare prospective and practicing mathematics teachers' work with diverse classrooms that are a result of today's multicultural and diverse society (e.g., Civil, 2007; Turner et al., 2016). As an example, the work of Moll and colleagues (1992) helped identify a means to disrupt issues of equity in the classroom and support teachers' work with diverse student populations. Their work connecting classroom and household practices of Mexican families in Arizona produced the landmark construct, *funds of knowledge* (FoK; Moll et al., 1992). Moll and colleagues describe *funds of knowledge* as the backgrounds, skills, and knowledge that have been historically and culturally

developed, and they argue that the integration of students' FoK into the school curriculum creates a more meaningful learning experience for students. Specifically, Moll and others began thinking about FoK as the "totality of experiences, the structuring of the households, whether related to work or play, whether they take place individually, with peers, or under the supervision of adults, helps constitute the funds of knowledge children bring to school" (Moll, Amanti, Neff, Gonzalez, 2005; p. 75). Essentially, the idea of FoK emphasizes the point that children bring mathematical knowledge to school that teachers can then capitalize to enhance their engagement with the curriculum.

Relatedly, Civil links FoK to the mathematics education by taking a sociocultural approach to mathematics instruction in her extensive work with families and mathematics teachers and students (e.g., Civil, 1992, 1993, 2007; Civil & Moll, 2001; Civil & Andrade, 2003; Civil & Kabru, 2004). Her work has significance to bridging the out-of-school and in-school mathematical experiences of students through mathematics curriculum and instructional design and is significant towards highlighting aspects of community and culture in the mathematics classroom. Throughout her time as an educational researcher, Civil often reflects on her experiences in the field. An instance of this is when Civil (2007) reflects on building community knowledge as a movement towards equity in mathematics education. In this piece, Civil highlights a key takeaway from her time on projects that utilized FoK as a critical piece of design—the importance of teachers being able to learn first-hand about the lived experiences of their students' local communities. Civil notes that this allowed teachers to view parents and the community as resources towards the development of mathematics curriculum modules and how teachers began seeing students' and their families' backgrounds and knowledge

as assets to their instructional practices. In addition, Civil describes the dilemmas and tensions she experienced when supporting teachers' integration of students' FoK with the mathematics curriculum. Of particular note here is her discussion of the tensions that arise as teachers manage "preserving the purity of the funds of knowledge, perhaps at the expense of the mathematics" (p. 16) and made decisions about what constitutes mathematics in the classroom. While intending to bring FoK into the classrooms, teachers faced challenges managing the dual mathematical and FoK goals during instruction.

Research utilizing FoK in mathematics education and the tensions and dilemmas described by Civil have laid a foundation for scholarship around bridging cultural and community knowledge with mathematical knowledge in today's mathematics classrooms. This helps provide more authentic experiences that allow students to engage in meaningful and relevant mathematics, affirms student identities in a way that helps them see their experiences as mathematical, and empowers students to use mathematics in ways that matter to them—all key tenants of culturally responsive teaching (Gay, 2000). An example of this playing out in the field of mathematics education is exemplified by the work conceptualizing student's *multiple mathematical knowledge bases* (MMKB; Turner et al., 2012) as a critical resource for teachers to recognize and make use of with diverse groups of students. In their work, Turner and colleagues developed and use student's MMKB as a means to prepare prospective teachers to meaningfully integrate children's mathematical thinking and cultural funds of knowledge. These scholars describe students' MMKB as "the understandings and experiences that have the potential to shape and support children's mathematics learning—including children's mathematical

thinking, and children's cultural, home, and community-based knowledge" (Turner et al., 2012; p. 68). Using MMKB as a framework, Turner and colleagues developed three cross-cutting learning modules for prospective teachers to learn about equitable teaching and that afford teachers opportunities to experience tensions and dilemmas that come with integrating funds of knowledge with the mathematics curriculum (Turner et al., 2016). For example, one of the learning modules this group developed has prospective teachers analyze mathematics classrooms, lesson plans, and video with an eye on how each afford opportunities for the teacher to elicit and build on students' MMKB (Bartell et al., 2015). The work of Turner and colleagues is significant because it makes a practical link between mathematical and cultural funds of knowledge as resources for teachers to use to create more meaningful curriculum and focuses mathematics teacher educators' attention to providing prospective teachers initial experiences with students' MMKB that include the tensions and dilemmas experienced when using these resources in today's mathematics classroom.

A focus on the complexity of teaching has also produced new conceptualizations of teaching. One example is Lampert's scholarship about the notion of the teacher as *dilemma manager*. Lampert's (1985) landmark work highlights the complicated and dynamic nature of teaching, where teachers experience and manage dilemmas in different ways. The construct of dilemma manager is significant as it provides an intellectual view of teaching that positions the teacher as making sense of and working through problems of practice. This conceptualization contradicts views of teaching as a series of straightforward decisions and positions the teacher as one who cannot always solve problems of practice quickly due to the challenging nature of instructional practice.

Three key aspects of the teacher as dilemma manager include the teacher (1) improvising and inventing during active negotiations of classroom interests and activity, (2) considering knowledge gained from their context when making decisions about the use of resources and recommendations from research, and (3) knowing that every problem is not solvable in the moment. Importantly, Lampert also notes that, in viewing dilemma management as a part of teachers' work, we must uncover and discuss the unsolvable problems of teaching. Furthermore, she recommends understanding the resources of which teachers make use and the role of these resources in managing the dilemmas of practice.

In addition to being relevant to how teachers manage dilemmas, resources are playing an increasingly important role in supporting teacher learning and practice. At the same time, resources are gaining greater prominence in scholarly research with the need to understand the relationship between mathematics teachers and resources (e.g., Adler, 2000; Ball & Cohen, 1993; Davis and Krajcik, 2005; Drijvers, 2012; Lloyd, Remillard, & Herbel-Eisenmann, 2009). In discourse about education, the clarion call for *more resources* in school mathematics is commonplace and subsequently hides the important decision of what constitutes a resource (Adler, 1998a). The complexity of resources is highlighted by Adler's (2000) broad conceptualization of what constitutes a resource and her creative use of viewing resource as a verb (i.e., teachers take up an active role in how resources are integrated and used to support their intended instructional and professional goals). Key from Adler's (2000) work is that, "As various resources are embraced by teachers, they take on specific and situated meanings in the practices and context of the mathematics classroom. They become visible and need to be rendered invisible" (p.

217). At a foundational level, Adler's (2000) contribution provides insight to the potential dilemmas and tensions teachers experience while drawing on resources (e.g., making a resource transparent in practice such that the resources is not a distraction but an aid to the mathematics being learned). Adler's work is also significant in that it begins to describe teachers use of resources as a verb, drawing attention to the critical role teachers take up in how resources are incorporated in practice. Along these lines, teachers are no longer passive users of resources but designers, creative users, and active decision-makers about contextualized and *lived resources* (Gueudet, Pepin, Trouche, 2009); suggesting that in the complex and dynamic work of teaching it is important to understand how teachers make sense and use of resources *in-practice-in-context* (Adler, 2000).

To further conceptualize resources in and for school mathematics, Adler (2000) highlights three initial categories: material (e.g., classroom, technology, curriculum materials), human (e.g., class size, teacher knowledge, parents, colleagues), and socio-cultural resources (e.g., language and time). However, as the field has progressed, other resources have emerged as relevant to informing the decision making of a mathematics teacher. The previously described FoK and students' MMKB are examples of this progress. Both FoK and students' MMKB act as resources for teachers to inform their practice, shifting students' mathematical and non-mathematical experiences to assets the teacher can capitalize on to enhance mathematics teaching and learning.

The emergence of literature around FoK and students' MMKB shows that it is important to take an expansive view of resources that extends, redefines, and includes the material, human, and sociocultural resource categories of Adler (2000). By way of

working with PreK-12 teachers and students, prospective mathematics teachers, and mathematics teacher educators and researchers, along with teaching high school mathematics, a more expanded view of resources has evolved that inform and enhance the work of mathematics teachers. This expanded view considers students' mathematical thinking and in/out-of-school experiences, classroom discourse communities, curriculum materials, mathematics education research and texts about teaching and learning mathematics, state and national teacher organizations (e.g., the Tennessee Mathematics Teacher Association and the National Council of Teachers of Mathematics), online and school-based communities of practice (e.g., school-based professional learning communities and online professional learning networks such as YouCubed.org and the mathematics twitter blogosphere—#MTBoS), virtual and hands-on manipulatives (e.g., Desmos, an online graphing calculator, and the National Library of Virtual Manipulatives), digitally distributed lesson plans (e.g., NCTM Illuminations, Estimation180, and WhenMathHappens), and in-person and online professional learning opportunities (e.g., internet-based, district, state, and national professional development sessions and workshops) as resources teachers have available to inform their practice.

The list of resources reflects a variety of resources that can nest inside and extend the categories delineated by Adler (2000). Another individual's list is likely to look different from mine. Here, it is important to note that teachers and researchers define the term *resources* in a multiplicity of ways. While drawing on the work of Adler to initially think about resources, this conceptualization of resources extends her conceptualization to include teachers' knowledge of students, classroom culture, communities of practice, and newfound access to a plethora of information and networks through the internet.

This expansive view of resources fundamentally broadens our understanding of the relationship between the teacher, the resource, and the decision-making process that takes place in resource integration. This view also broadens what educational researchers consider as resources available to teachers in a variety of contexts. With an expansive view, it is important to keep in mind the active role teachers take when integrating resources. Teachers do not utilize resources as is but rather interpret, adapt, and make sense of resources through their professional knowledge, goals, purposes, and context. The interaction between resources and the teacher reflects decision making and effects the ways in which resources are utilized in classroom settings.

Thus far, the preceding paragraphs have emphasized the complex and dynamic work of teaching through a discussion of tensions and dilemmas and considered an expanded view of resources that also considers the relationship between the teacher and the resource. The remainder of Chapter 1 is dedicated to describing an overview of the dissertation study by way of a statement of the problem, purpose and significance of the study, and the limitations and delimitations relating to this study.

Statement of the Problem

The relationship between dilemma management and an expanded view of resources is an underdeveloped area of research within mathematics education (e.g., Adler, 1999; Baxter & Williams, 2010; Lampert, 1985; Little, 2007). Calls for localized understandings of resources and dilemmas derives from an understanding that teachers play an active role in deciding what and how to teach (Adler, 2000; Lampert, 1985). Teachers' make sense of and utilize resources in different ways in order to meet different goals. In addition, a lack of contextual framing for this area of mathematics education

research leaves much to be desired when considering methods to support teachers in a variety of settings, including rural contexts.

The call to gain localized understandings of resources and dilemmas has led me to position this study in a rural community in the Appalachian region of the Southeast United States. This is one of many rural communities in the United States and is itself dealing with issues relating to poverty (United States Census Bureau, 2016). Generally, rural communities in the United States are numerous and diverse; however, there exists a dearth of educational research about the rural experience (Burton, Brown, and Johnson, 2013). This leads to “a pragmatic necessity and empirical imperative to understand the individuals who teach in these districts” (Burton, Brown, and Johnson, 2013, p. 26). The literature also points to a deficit view of teachers and teaching in rural contexts. Teachers in rural communities are described as professionally isolated and distant from resources, inflexible and resistant to change, and lacking knowledge and credentials (Burton, Brown, and Johnson, 2013). Similar to the need to understand resources and dilemmas in-practice-in-context, mathematics education research must understand the circumstances surrounding teaching and learning in rural educational settings in-practice-in-context—not to compare with others but to understand within (Howley and Gunn, 2003).

Finally, rural communities are often a site for education funding issues (Harmon, Gordanier, Henry, & George, 2007). These districts often do not have the same access to material and human resources as their urban and suburban counterparts, particularly with respect to access to professional learning opportunities and instructional technologies (Panizzon, 2015; Roberts, 2005; Sundeen & Sundeen, 2013). However, with the

emergence of digital technologies and the internet, rural communities now have access to resources of which they previously did not. While not being limited to rural communities, the advancements in technology have allowed for all mathematics teachers to have greater access to resources (Pepin, Gueudet, & Trouche, 2013). However, chronic poverty continues to have implications for technology accessibility in rural areas (Duncan, 2005; Malhoit, 2005).

The previous discussion of dilemmas, resources, and rural education highlights the issues facing the field of mathematics education and the need for understanding relationships between resources and teachers in context. Given this, there is a need for research into the relationship between resources and teacher decision making in response to dilemmas of practice.

Purpose of the Study

As mentioned previously, there is a need to further understand resources and dilemmas in-practice-in-context. Thus, the purpose of this study is to take a situated perspective in understanding how mathematics teachers', in a rural southeastern United States school district, conceptualize and use resources to mediate dilemmas of practice so that they can act professionally.

Based on the aforementioned purpose, this study focuses on the following research question: *How do mathematics teachers in rural settings make use of resources to mediate dilemmas in practice?* This research question was designed to direct the “looking and the thinking enough and not too much” (Stake, 1995, p. 15) towards the relationship between dilemmas and resources. The following sub-questions are explored:

1. From the teachers' perspective, what are the dilemmas of practice that mathematics teachers in a rural setting experience?
2. How do mathematics teachers in rural settings conceptualize resources for the teaching and learning of mathematics?

Significance of the Study

In terms of educational theory, this study has significance in that it has the potential to make four contributions. First, this study informs an underdeveloped area in mathematics education—conceptualizing resources in and for the teaching and learning of school mathematics, particularly taking a view of resources as being *in-practice-in-context* (Adler, 2000). Second, this study contributes additional, situated findings related to resources rural mathematics teachers' make use of to cope with and manage the dilemmas of practice they experience. Third, this study supports a starting point to understanding a learning trajectory about resources. Lastly, there exists deficit storylines in the literature on rural education where rural teachers are the problem and notions of *place as obstacle* or *place as deficit* are predominant (Burton, Brown, & Johnson, 2013). Instead, this study contributes an examination of mathematics teachers' in rural communities with the objective of understanding the realities of teaching in a rural community from the perspective of the rural mathematics teacher. Careful attention will be made to viewing the teachers' circumstances and experiences as assets that support their practice and engagement in the work of teaching; furthering our collective conception of what it means to be a teacher in the United States.

From a practical standpoint, this study has significance in two ways. First, the study provides a better understanding of aspects of effective resources, from the

viewpoint of rural mathematics teachers, to support their future design. Second, the study bolsters the mathematics education communities' understanding of effective resources that mediate dilemmas of practice, further supporting the work of mathematics teacher educators and the design of mathematics teacher professional development—particularly the development of teachers preparing to teach in rural communities.

Limitations

As with any qualitative study, the results are limited to the context in which the study is being conducted. Though contextually bound, the results can support the basis for further research about resources and dilemmas in secondary mathematics schooling, particularly for mathematics teachers in rural settings. It is up to the reader to decide how and if the results apply in cases beyond this one.

Additionally, the small number of participants calls into question the studies' representativeness and generalizability. However, this was purposeful to afford a depth of understanding necessary for a qualitative study that intends to capture participants' voice and perspective. With a larger sample size, the likelihood of achieving adequate depth would be significantly decreased.

A final limitation of the study is my pre-existing relationship with four of the five participants. As discussed in Chapter 3, I have conducted professional development sessions within this district for four years. As a professional development facilitator, my orientation towards mathematics is broadly communicated. This could have influenced how participants made decisions and filtered what they decided to share. To adjust for this, I made sure participants were aware of safeguards for confidentiality and explained that I was there to understand, not judge.

Delimitations

The goal of this study is not to make broad claims, but rather to focus on the details that might get lost in a larger data set. Therefore, I limited the number of participants to five. This provided a more personal relationship to be built with the participants that resulted in a robust dataset attached to each participant. I was also able to transcribe all interviews and immerse myself in the data with this sample size.

Additionally, the study did not take place in the county in which I live. Because of this, I drove to the district for classroom observations and interviews. Though I would attempt to schedule multiple events on a single day, individual teacher schedules did not always make this possible, and severe weather often forced multiple instances of rescheduling due to school closures.

Organization of Study

In the previous paragraphs, I have provided the rationale for studying how mathematics teachers in rural settings make use of resources to manage the mediation of the dilemmas they experience. In the chapters to follow, Chapter 2 consists of a literature review, highlighting the theoretical framework and influential ideas of the dissertation study. In Chapter 3, I then provide an overview of the methodology used to carry out the data collection and analysis. In Chapter 4, I continue with the insights gained through the data analysis. Finally, I discuss the key themes and the implications of the study.

CHAPTER TWO

LITERATURE REVIEW

In my time working on the Math Counts Project¹ (MCP) the project team noticed how resources, together with purposefully planned and designed discourse, created spaces to talk about STEM teaching and learning issues based in both research and teachers' lived experiences. The goal of the MCP was to develop teachers' knowledge of content and pedagogy through participatory and discussion-based professional development sessions, and, in these sessions, teachers' were positioned as experts of their students' and craft as we discussed and presented resources (e.g.—manipulatives, books, and tasks) and relevant research (e.g.—learning trajectories and high-leverage practices) about mathematics content and pedagogy (Hodge, Cheng, King, & Kim, 2018). By positioning teachers as experts, we noticed that they not only participated with a knowledge of content and pedagogical orientations and practices, but also as experts of resources that integrate with and support their practice. These resources ranged from ideas gained from colleagues and previous professional development experiences to recalling student thinking in their localized classroom context and considering life and community-based experiences. From these experiences, we found that the resources teachers make sense of extends beyond the materials we discussed and support a broader conceptualization of resources for the teaching and learning of mathematics. My

¹ Math Counts Project was funded through *Department of Education Math and Science Partnership* and *Tennessee Department of Education* grants. The project team was led by Dr. Lynn Liao Hodge, Department of Theory and Practice in Teacher Education at the University of Tennessee, Knoxville, and Gale Stanley, Campbell County Public Schools.

experience as part of the MCP team has informed the nature of the theoretical framework and literature review described below.

In the following sections I discuss the theoretical framework and literature that informs the dissertation study. I begin the chapter by detailing a situated perspective as the theoretical underpinning of the study. Because this study is looking at how rural middle and high school mathematics teachers utilize resources to mediate the dilemmas they experience, I will the discuss the three domains of literature that were reviewed: rural teaching contexts, resources and dilemmas, and reform in mathematics education.

Situated Perspective

This dissertation study rests on tenants of a situated perspective as its primary source for theoretical framing. As others have noted (Burton, Brown, & Johnson, 2013; Howley & Gunn, 2003; Sher, 1977), there is a need to look within rural communities that represent diverse groups of individuals who have little in common except their classification as being *rural*. Scholarship has also noted the need to consider schooling within these contexts through the framework of rural identity, agency, and culture (Corbett, 2007). These calls for a contextual and localized understanding of education through rural communities' activity and culture align with a situated theory of cognition and learning.

The work of Brown, Collins, and Duguid (1989), Lave and Wenger (1991), Greeno, (1997), and Cobb and Bowers (1999) form the basis for the situated perspective used in this study. Important from each of these scholars' approach to understanding the nature of knowledge and learning is that knowledge and learning are situated as a product of the activity, context, and culture in which they are taken up.

In particular, Brown, Collins, and Duguid (1989) note the impact that social and physical context and school culture have on meaning making and learning, highlighting the integral relationship activity and situation have with knowledge. This is understood by Brown, Collins and Duguid (1989) initial conceptualization of cognitive apprenticeship as an approach to teaching and learning; where environment and task (i.e., the situation and activity) have influence on the knowledge and beliefs being developed and knowledge is viewed as a tool.

Highlighted from the work of Lave and Wenger (1991) is their development of *legitimate peripheral participation* as a central characteristic to viewing learning as a situated activity. This concept pieces together what it means to be a member of a group entering a culture and community of practice, and notes that access to a practice is dependent on one's access to its resources. Lave and Wenger (1991) also contribute the view that a situated perspective implies emphasis on understanding the whole person and viewing activity in and with the world. Their work is central to informing the situated perspective used in this study, where resources are understood through experiences in-practice-in-context.

In addition, in a lively debate in *Educational Researcher* on views of learning and activity, Greeno (1997) suggests the overarching goal of a situated perspective is to build: toward a more comprehensive theory by analyses of structures of information that are produced by the material and representational resources in their environments... [offering] a route from analyses of interactive systems toward a more detailed analyses of information structures and processes by which information is developed in communication and collaborative activity. (p. 15)

Although these remarks by Greeno were published in 1997, they are still relevant today, and highlight the effectiveness of a research agenda that aims to understand information structures of socially organized activity. Cobb and Bowers (1999) also highlight the importance of understanding the *actor's* (i.e., agent's) viewpoint and note key perspectives on the necessary number of units of analysis necessary to draw conclusions in research studies.

While a main goal of these scholars' work is to understand the nature of teaching, learning, and transfer (i.e., how knowledge translates to new contexts and problem situations), I draw on their collective conceptualizations of a situated perspective to bring the participants' viewpoint to the forefront; understanding how rural mathematics teachers' make use of resources to inform their practice and how resources are experienced and integrated in-practice-in-context. The works mentioned inform the conceptualization of a situated perspective that focuses on meaning making from the context and perspective of local actors. Using this lens allows for participant (rural middle and high school mathematics teachers) perspectives to be highlighted within a situated context (teaching mathematics with resources in a rural southeastern United States school district). In addition, here it is important to consider the cultural lifeways, school activity, and meaning making in the participants conceptualization of resources and their experiences with dilemmas in the teaching and learning of mathematics. In this sense, by taking a situated approach to the study, the participants' lifeways and cultural context come to the forefront and afford the opportunity to gain a unique snapshot of the resources and dilemmas of rural mathematics teachers in-context-in-practice (Note the shift from Adler's (2000) "in-practice-in-context" to "in-context-in-practice." Where

employing a situated perspective places the context as the initial piece informing teacher practice and activity).

Rural Teaching Context

Two issues make it difficult to understand and support mathematics teaching in rural communities. The first issue is that research considering the rural teaching experience is scant (Brown & Johnson, 2010; Burton, Brown, & Johnson, 2013); while there does exist research on rural communities it rarely highlights the rural experience and instead draws comparisons between rural communities and their urban and suburban counterparts. An example of this is Byun, Meece, and Irvin (2012), who explore factors effecting disparities between rural and non-rural postsecondary attainment. While their work has meaning, at the same time it is furthering a narrative of a rural disadvantage and focusing on *rural* as deficit rather than as a site that has success and value on its own. More broadly speaking, this is an example of educational research that shifts from a local situated understanding that considers culture and context towards a comparative analysis against those in non-rural settings.

The second issue is that teacher shortage crisis has impacted recruitment and retention of teachers in rural school districts and many rural teachers feel underprepared to teach in rural settings (Burton, Brown, & Johnson, 2013). The issues of teacher shortage and retention has led to fewer benefits, lower pay, and a reality of placing less qualified teachers in many rural math, science, and special education classrooms (Cady & Rearden, 2009; Zost, 2010). In addition, the issue of teachers being underprepared to teach in rural settings has led to high turnover rates and can be linked back to “teacher preparation programs rarely [preparing] teachers adequately for the unique nature of

teaching in rural schools” (Burton, Brown, & Johnson, 2013, p. 7). These two issues compound and make it difficult to understand and support teachers’ work in rural communities.

The scholarship that does exist in this area offers helpful points and provides direction for future research. First, the literature tells us that teachers choose to teach in rural settings because of a sense of community within and outside of schools (Arnold, Newman, Gaddy, & Dean, 2005). Second, even with a sense of belonging in rural schools, Burton and Johnson (2010) found that teachers often feel underprepared for teaching in rural communities. These authors cite a lack of place-conscious teacher education that ill-prepares teachers to teach in rural context. They also note how being from a rural setting is “often an untapped resource for teaching and not a deficit” (Burton & Johnson, 2010, p. 384). Third, studies have noted that a systematic approach—continuous and content-specific professional development, follow-up assistance, lead teachers, walk-throughs, and external evaluation—is needed to support reform mathematics education reform efforts in rural schools (Harmon, Gordanier, Henry, & George, 2007). In addition to this idea of comprehensive support, it is important for these efforts to be embraced fully by both the teacher and district administrators, as these efforts are often marginally and incrementally used to modify curriculum and instruction (Howley, Larson, Andrianaivo, Rhodes, & Howley, 2007).

Given this body of literature, little has been done to understand the relationship between resources and teachers experiences in rural settings and in response to mathematics education reform efforts. In addition, little has been done to understand how digital technologies and the internet have impacted the practice of teaching in rural

settings. These are important issues to consider as resources become plentiful professional learning networks, once viewed inaccessible, become financially and logistically accessible for all.

Dilemmas and Resources

Clearly, teachers encounter dilemmas in their practice on a daily basis. In the broadest sense, dilemmas are “a wide variety of problematic situations that defy easy answers” (Windschitl, 2002, p. 165). In response to dilemmas, resources can act as a support for teachers’ work (Lampert, 1985). When viewed together, dilemmas and resources provide an analytical lens to inform our understanding of teacher learning and instructional improvement in response to the actual work of teaching.

Focusing on teachers’ work in the mathematics classroom, Lampert (1985) defines *teaching dilemma* as a situation where the teacher encounters equally undesirable alternatives as the goals of teaching fluctuate in practice, creating a self that must manage and cope with contradiction. Byers (1984) also describes the work of teaching through a focus on dilemmas. He contributes that, “the greatest potential in the teaching situation lies in learning to work with the inevitable dilemmas which arise in the classroom... tension is not viewed as evidence of inadequacy... rather it points to the fact that real educational work is going on” (p. 31). Byers and Lampert both share an understanding of teaching dilemmas that allows for an analysis to link dilemmas to the resources that help teachers mediate them. For this we begin to understand the activity of teaching in a way that pushes the nuanced complexity of teaching to the forefront and gain an appreciation for how teachers manage competing goals and make informed decisions based on contextual and situational factors. Viewing teaching in this way lays credence to the

proactive role of the highly effective teacher as one that pursues a mathematical agenda, supports students' mathematical development, uses student thinking to make informed decisions, and supports the development of productive classroom norms in hopes of having students develop productive dispositions towards mathematics (McClain, 2003; McClain & Cobb, 2001). These competing goals and actions create tensions in practice and produce the dilemmas teachers must work through on a daily basis.

Further, the proactive role of the teacher is a critical aspect to understanding how teachers go about managing dilemmas (Lampert, 1985, 2001). In her work, Lampert (1985, 2001) describes the deeply personal and contextual nature of teaching as reflected in how dilemmas are experienced and managed differently by teachers in localized ways. Lampert (1985) cements this view of teachers' work by describing the teacher as an active negotiator, a *dilemma manager*—one accepting disequilibrium while learning to cope with contradiction. Her description highlights the teacher as an active decision maker and is significant because it brings attention to the situatedness of teachers' activity in response to other actors, the environment, and their knowledge and experience. Taking the concepts of teaching dilemmas and dilemma manager, Windschitl (2002) offers precision by delineating four categories of dilemmas for constructivism in practice. These categories are conceptual dilemmas, pedagogical dilemmas, cultural dilemmas, and political dilemmas. Conceptual dilemmas include how teachers go about understanding constructivism in relation to their current beliefs about teaching and learning. Pedagogical dilemmas include teachers' mastery of facilitation and management of discourse and collaborative work in the classroom. Cultural dilemmas include negotiating what activities are valued in the classroom and managing students' beliefs

and practices in response to constructivist norms and ideals. Lastly, political dilemmas describe the management of accountability to various education stakeholders and the school community. With a broad understanding of dilemmas in teacher's practice, we can now have a need to better understand the ways in which resources support teacher's management of the various dilemmas they experience. This is in response to Lampert's (1985) call for further analysis into the role of resources in dilemma management and brings about a need to first understand what constitutes a resource in mathematics teaching and learning.

In her work, Adler (2000) moved beyond the bounds of a material conception of resources to begin considering the socio-cultural and human resources teachers engage with through their work. For Adler, material resources consist of the technologies, school mathematics materials, mathematical objects, and everyday objects; human resources consist of the teacher themselves' and the teachers by which they interact with in a collegial way; and, socio-cultural resources consist of language and time. This conceptualization of resources was grounded in Adler's work and experiences with teachers in a South African context. Specifically, she approached this conceptualization of resources through the *dilemma of transparency*. For Adler, the dilemma of transparency describes the ways in which a resource is rendered invisible in the practice of teaching mathematics; where "transparency is not a property of the resource, but a function of how the resource is used and understood within the practice in context" (p.217) and is significant as it features a take on resources that places the resource in the context of teachers decision making with resources rather than viewing the resource as replacing or doing the work of the teacher. It is here that Adler begins understanding

resources in-practice-in-context and how the transparency of resources can enable or hinder access to powerful mathematics teaching and learning.

Others have also brought together dilemmas and resources in their work. Civil (2007) describes the dilemma of managing content goals that align with funds of knowledge. In this she is supporting teacher development of meaningful mathematical learning experiences that stay true to mathematical content and the home and community funds of knowledge that are being used in mathematics instruction. Unique to her work is the idea of parents, the home, and community as a resource for teaching at the planning, implementation, and reflection phases of teachers' work. Ball (1993) highlights additional resources through an exploration of dilemmas in teaching elementary mathematics, discussed how teachers' personalities and professional communities and discourse act as resources for a teacher's practice. In her classic article, Ball describes her experiences teaching a third-grade class and the teaching dilemmas she experiences. She draws attention to three dilemmas: teaching content, respecting students as thinkers, and creating community. In her description, Ball makes clear the details and decision-making involved coming face to face with dilemmas that have no clear solution and highlight the necessity of reflection and discourse as critical resources for understanding and informing her teaching. Discourse can also be seen as a resource in Horn and Little's work. In their study, Horn and Little (2010) describe how patterns of teacher discourse and conversational routines, within a professional learning community, provide varying affordances for professional learning opportunities. This work is important as it describes how teacher discourse and professional communities act as a resource for unpacking their teaching experiences and growing within the profession.

Teacher Learning

Considering the debate around teacher knowledge necessary for high-quality teaching (e.g., Ball & Bass, 2003; Ball, Thames, & Phelps, 2008; Koehler, Mishra, & Cain, 2013; Schulman, 1986), there has been additional interest in research around teacher learning that supports teachers' development of knowledge and practices (e.g., Clarke and Hollingsworth, 2002; Drake, Spillane, & Hufferd-Ackles, 2001; Fiesler & Firestone, 2006; Horn, 2005; Putnam & Borko, 2000; Remillard & Bryans, 2004). In an effort to synthesize and create a conceptual framework for research on mathematics teachers' learning, Goldsmith, Doerr, and Lewis (2013) noted major areas of research, themes, and recommendations for research about mathematics teacher learning. Before delving into their work, it is important to note that the authors draw on Clarke and Hollingsworth (2002) to consider teacher learning and professional growth as a dynamic and interactive enterprise, where enactment and reflection are critical to support changes in teacher knowledge, beliefs, and/or practices.

The major areas of research on mathematics teacher learning that Goldsmith, Doerr, and Lewis (2013) describe extends from their literature review on the matter. They found that the literature consists of six domains that explore teachers' (1) beliefs, identity, and dispositions, (2) instructional practices, (3) collaboration/community, (4) attention to student thinking, (5) mathematics content knowledge, and (6) mathematics curriculum and instructional tasks. The authors outline each area and take a critical stance to observe gaps in the literature. For example, with respect to the literature cited for curriculum and instructional tasks, the authors note that while there is a valid "argument for the potential of curriculum materials and instructional tasks to support

teachers' learning, most studies do not illuminate how particular features of curriculum or instructional tasks influence teachers' learning... Hence, as a field, we still know relatively little about what is inside the black box of teacher learning about and from curriculum materials" (p. 19).

Describing what we can surmise from the literature, Goldsmith, Doerr, and Lewis (2014) make note that we can observe three ideas: (1) teacher learning occurs incrementally and iteratively, (2) interventions vary based on impact, and (3) that research needs to focus more on teacher learning, rather than on program effectiveness. These three ideas inform the recommendations from their work. First, they recommend that the field of mathematics education research should look to vary research methodologies (large-scale, small-scale, quantitative, qualitative, mixed methods) in their work. Second, the field needs to develop a common means of reporting research, common standards for mathematics teacher professional development, and common language around teacher learning. While there appears to be a plethora of literature on the subject, there is still a need for further investigation and cohesion towards an intricate understanding of teacher learning. Again, of note here is the need for further research on teacher learning and teacher education for rural educational settings (Burton & Johnson, 2010).

Teacher Learning and Curriculum Materials

Curriculum materials are developed and sold with lofty goals of being agents of instructional improvement within mathematics education; however, curriculum developers have failed to recognize the teacher learning that must take place for teachers to utilize the materials effectively (Ball & Cohen, 1995). Teachers also select, adapt, and

shape curriculum materials based on students and their content and pedagogical knowledge, often causing a disconnect between the intended and enacted curriculum and causing many teachers make their own curriculum out of disdain for the textbook (Ball & Cohen, 1995). Ball and Cohen (1995) make the following recommendations to improve the contribution of curriculum materials to teacher learning: (1) the field must deepen our understanding of student thinking to inform curriculum development, (2) teacher guides should be more conversational and orient teachers to the possibilities of the curriculum, and (3) depth within curriculum materials is valued, but the developers should be humble about the complexities of teaching. Ball and Cohen (1995) also suggest that while curriculum materials are a piece of instructional improvement and supporting teacher learning, the focus of curriculum fidelity within districts and professional developments—which often act as quality assurance—to support the adoption of curriculum is bypassing an opportunity for substantive professional development.

Since the landmark recommendations of Ball and Cohen (1995), the concept of curriculum materials for teacher learning has taken on a new name—*educative curriculum material* (ECM); a distinction necessary to emphasize the critical role curriculum materials take on in supporting teacher learning to meeting the high expectations of education. In general, ECMs are designed to promote both teacher and student learning and increase teacher knowledge in “specific instances of instructional decision making” (Davis & Krajcik, 2005, p. 3). These materials are also designed to support teachers’ development of a general knowledge about the teaching and learning of mathematics to apply more flexibly in practice. In order to design ECMs effectively, Davis and Krajcik (2005) define five aspects involved in teacher learning: (1) the

integration of one's knowledge of content, teaching, and learning, (2) the application of knowledge to make instructional decisions, (3) participating in discourse about teaching, (4) being mindful of the plethora of teacher practices, and (5) understanding that teacher learning is situated in teachers' practice. Using this conception of ECMs and teacher learning, Davis and Krajcik (2005) describe guidelines for effective ECMs the build off of the work of Ball and Cohen (1995); they suggest that ECMs should: (1) help develop teachers' anticipation and interpretation of student thinking in the context of instructional activities, (2) support teachers' learning of subject matter, (3) consider ways to relate units throughout the year, (4) make visible the developers pedagogical orientation within the curriculum materials, and (5) promote teachers' development of a pedagogical design capacity.

The above-mentioned ECM design guidelines are supported with design heuristics aimed at helping curriculum developers create ECMs that promote the teacher learning necessary for education reform. Design heuristics are intended to frame ECMs to enable teachers to learn for themselves. The nine design heuristics, intended for science ECMs, consist of *supporting teachers in engaging students with scientific phenomena*, *supporting teachers in promoting scientific communication*, and *supporting teachers in the development of subject matter knowledge*. These heuristics are also categorized by supporting teachers subject matter knowledge, pedagogical content knowledge for scientific inquiry, and pedagogical content knowledge for science topics. While framing their article around ECMs for science teachers, Davis and Krajcik (2005) make note that mathematics ECMs that attend to their recommendations and guidelines

would instead focus on features of inquiry methods in mathematics teaching and learning and mathematical knowledge for teaching (Hill & Ball, 2009).

Curriculum Enactment

It is unfair to expect teachers to develop their own mathematics curriculum while at the same time it is unfair to dismiss the individual professional enacting the curriculum. With this there exists two overarching orientations toward mathematics teaching and learning—traditional and reform. These two approaches to mathematics teaching and learning vary in the role of the teacher, student, and mathematics and the impacts on conceptions of knowledge, beliefs, and mathematical identities (Boaler, 2002). Of note, reform-oriented teaching emphasizes inquiry-based methods of instruction that support the development of student practices and habits of mind, creating flexible problem solvers and students who can reason mathematically (NCTM, 1989, 2000, 2014). Critical to supporting the enactment of high-quality (reform-based) mathematics instruction at scale are curriculum materials (Ball & Cohen, 1995; Davis & Krajcik, 2005; Stein & Kaufman, 2010). Stemming from this perspective, a critical site for study is how teachers’ go about making decisions and enacting the curriculum.

In a notable piece, Remillard and Heck (2014) conceptualize the curriculum enactment process in mathematics education. These authors describe curriculum enactment process as starting with an official curriculum that moves through the design of instructional materials, the teacher-intended curriculum, the enacted curriculum, and ends with student outcomes. This process is complex and allows for various points of the enactment process to be further investigated and understood in relation to the teacher.

Additionally, the existing literature on rural settings that focus on supporting teacher-intended and enacted curriculums have found that, in addition to understanding the role of curriculum materials, professional development, follow-up, and teacher support is necessary for continued improvement (Harmon, Gordanier, Henry, & George, 2007; Howley, Larson, Andrianaivo, Rhodes, & Howley, 2007).

High Leverage Practices and Content

Teacher quality has been identified by many to be the single greatest factor contributing to student achievement (McCaffrey, Lockwood, Koretz, & Hamilton, 2003; Rowan, Correnti & Miller, 2002). To be a “highly qualified” mathematics teacher is different than implementing high-quality mathematics instruction. On the one hand, a highly qualified teacher might be defined through a set of variables such as degree attainment, edTPA (Teacher Performance Assessment for teacher candidates) and evaluation scores, and student assessment data. On the other hand, high-quality mathematics instruction is a set of actions, practices, dispositions, and moment-to-moment decision making that are less easily defined. While policy makers, university representatives, and other stakeholders might agree to a definition of a “highly qualified” mathematics teacher, high-quality mathematics instruction could represent many things to many stakeholders in mathematics education and take many forms in practice.

In the current body of literature, high quality instruction is widely conceptualized as a bringing together of high leverage practices and high leverage content in the mathematics classroom. High leverage practices constitute impactful, core practices in math and science that have significant consequences for students’ learning (Ball & Forzani, 2009; Windschitl, 2012). High leverage content is defined as content that is

foundational to the K-12 mathematics curriculum and includes knowledge that is essential for mathematics teaching and learning (Ball, Garcia, & Shaunnessy, 2013; Roschelle et al., 2009). Together high leverage content expands our focus on mathematics teaching and learning from “What do teachers need to know?” to “What do teachers need to do?” and involves identifying core practices and decomposing them (Ball & Forzani, 2009; Lampert, & Graziani, 2009). An example of a high leverage practice is proactively guiding a whole-class discussion that introduces a complex task (Jackson, Garrison, Wilson, Gibbons, & Shahan, 2013). Examples of high leverage content in math include analyzing and interpreting data, the idea of equivalence, and ratios and proportions.

This is the typical way that the field of mathematics education thinks about teaching—content and pedagogy. However, this study introduces the vision of the teacher as dilemma manager (Lampert, 1985), shifting the focus again from “What do teachers need to do?” to “How do teachers make decisions about what they are doing?” This is a small, but significant shift of our focus towards understanding mathematics teaching and learning through teacher decision-making, both small and large, that is part of teaching. This shift also brings focus to the enactment of teaching that blends aspects of theory, practice, and the individual, and lays in contrast to typical conceptualizations of teaching that focus on content and pedagogy.

Summary

By viewing teaching through the situated activity of managing dilemmas, we have begun to better understand the contextualized nature of teaching and how resources, such as funds of knowledge and communities of practice, support teacher practice and

professional growth. Taking a broadened understanding of *what a resource is*, allows for a more creative and localized consideration of teachers' instructional and professional decision making in-practice-in-context. Additionally, the literature around teacher learning, curriculum materials, and curriculum enactment situates the potential for material and immaterial resources to support high-quality mathematics teaching at scale. Thus, by taking a situated perspective that considers teachers' work through the management of dilemmas mediated by resources, this dissertation study employs the previously described theoretical framework and understanding of literature to investigate the localized work of mathematics teaching and resources in a rural setting.

CHAPTER THREE

METHODOLOGY

The purpose of this study is to uncover and understand how rural secondary mathematics teachers (RSMTs) conceptualize resources and how the resources they conceptualize mediate the dilemmas they experience. Although resources teachers utilize in practice have been recognized, the mediating relationship these resources have with dilemmas of practice teachers experience is unclear. In an attempt to learn more about how resources mediate the dilemmas RSMTs experience in-context-in-practice, an instrumental qualitative case study (Stake, 1995; Yin, 2014), was selected as the methodological tradition to be used for this study. The use of qualitative case study is relevant as it provides a research framework that observes the uniqueness and commonalities of individual realities (Stake, 1995); bringing the voice, context, and stories of RSMTs to the forefront.

The methodological descriptions that follow in this chapter stem from tenants of an instrumental case study, where a single case is used to gain a general understanding of dilemmas and resources in-practice-in-context (Stake, 1995; Yin, 2014). In gaining a general understanding of resources and dilemmas I am acknowledging that each can vary by location and time and I expect the case study to yield something greater than an understanding of the particular case (Stake, 1995). To gain this general understanding the research question, *How do mathematics teachers in rural settings make use of resources to mediate and manage dilemmas in practice?*, is designed to highlight the topics of resources and dilemmas as conceptual structures while recognizing their situatedness from beginning to end (Stake, 1995).

The following sections provide details on the study's research design, research context, participants, data collection and analysis procedures, and how methodological concerns were handled. It is also important to note here that all names of people and place are pseudonyms.

Research Design

Recall that this study is framed by a situated perspective and is guided by the following research question: *How do mathematics teachers in rural settings make use of resources to mediate dilemmas in practice?* Additionally, two sub-questions were introduced:

1. From the teachers' perspective, what are the dilemmas of practice that mathematics teachers in a rural setting experience?
2. How do mathematics teachers in rural settings conceptualize resources for the teaching and learning of mathematics?

By focusing the study around a puzzlement about the mediating relationship between the resources and dilemmas of mathematics teachers, situated in a rural setting, qualitative case study was chosen to guide the research design. This research technique was employed because qualitative case study is expected to catch the complexity and uniqueness within and across a case (Stake, 1995) and, "facilitate exploration of phenomenon within its context, using a variety of data sources" (Baxter & Jack, 2008, p. 544).

A central feature of case study is that it is understood through a bounded system of time, place, and participant, each of which are decided by the researcher (Stake, 1995). For this study, time is bounded by data collection occurring in the Spring of 2019. In the

background of the Spring 2019 semester, both a multi-faceted national mathematics education reform movement and state-level changes in mathematics curriculum and assessment are shifting mathematics educator's conception of what is expected to place in the math classroom. This adds color to the study by conducting the study at this time places our understanding of resources and dilemmas in the conception about what it means to teach and learn mathematics is changing in expectation, policy, and practice, causing its own set of dilemmas for teachers to experience. In addition, with respect to the time of this study, the advancements of digital technologies and the internet have led to a growing multi-dimensional network of digital tools and communities of which teachers have opportunities to interact. With respect to place, this case study is bounded to Wagon Wheel Schools (WWS), a rural Appalachian school district in the southeast United States. It is important to note that though this study is bounded to WWS, technology has allowed place to act relative to where one engages. Finally, considering *participants*, this study is bounded by 3-5 teachers from middle and high schools in CCPS, and are selected in a way that maximizes what I can learn from the participants (Stake, 1995).

Given the question being asked in this study, along with calls for a localized understanding of resources and dilemmas and the dearth of research on education in rural communities (Adler, 2000; Burton, Brown, & Johnson, 2013; Brown & Johnson, 2010; Lampert, 1985), a qualitative case study provides an appropriate approach to conducting research on this topic and tease out its problems and complexities.

Design overview. Figure 1 illustrates the key components for this study. An overview of the research design is diagramed in Figure 1 and further detailed in the sections to follow.

Research Context

In conducting research using case study, the context in which the case exists is of vital importance (Yin, 2014). The following paragraphs describe the school district context and my pre-existing relationship with members in the school district.

District context. The district in which this study is situated is a rural school district in the southeastern United States. According to the United States Census Bureau (2016), the county supports roughly 40,000 people. The majority of the population is white (97.5%), with 24% of persons in poverty and a median household income of close to \$33,500. The census bureau estimates that 49% of persons aged sixteen and older are in the labor force and the average travel time to work is roughly 25 minutes. In addition, close to three quarters of persons age twenty-five and older are high school graduates and one out of ten of persons have obtained a bachelor's degree or higher.

The county consists of eight elementary, two middle, and two high schools. According to the districts' 2016-17 State Department of Education Report Card, WWS has approximately 375 teachers and serves 5,750 students, of which 45% are economically disadvantaged and 15% have a disability. The district graduates a little over 90% of students, with an average ACT score of 17.6, where the average mathematics ACT score is 17 and only 11% meet the ACT College Readiness benchmark of scoring a 22 in mathematics. In terms of student performance on state mathematics

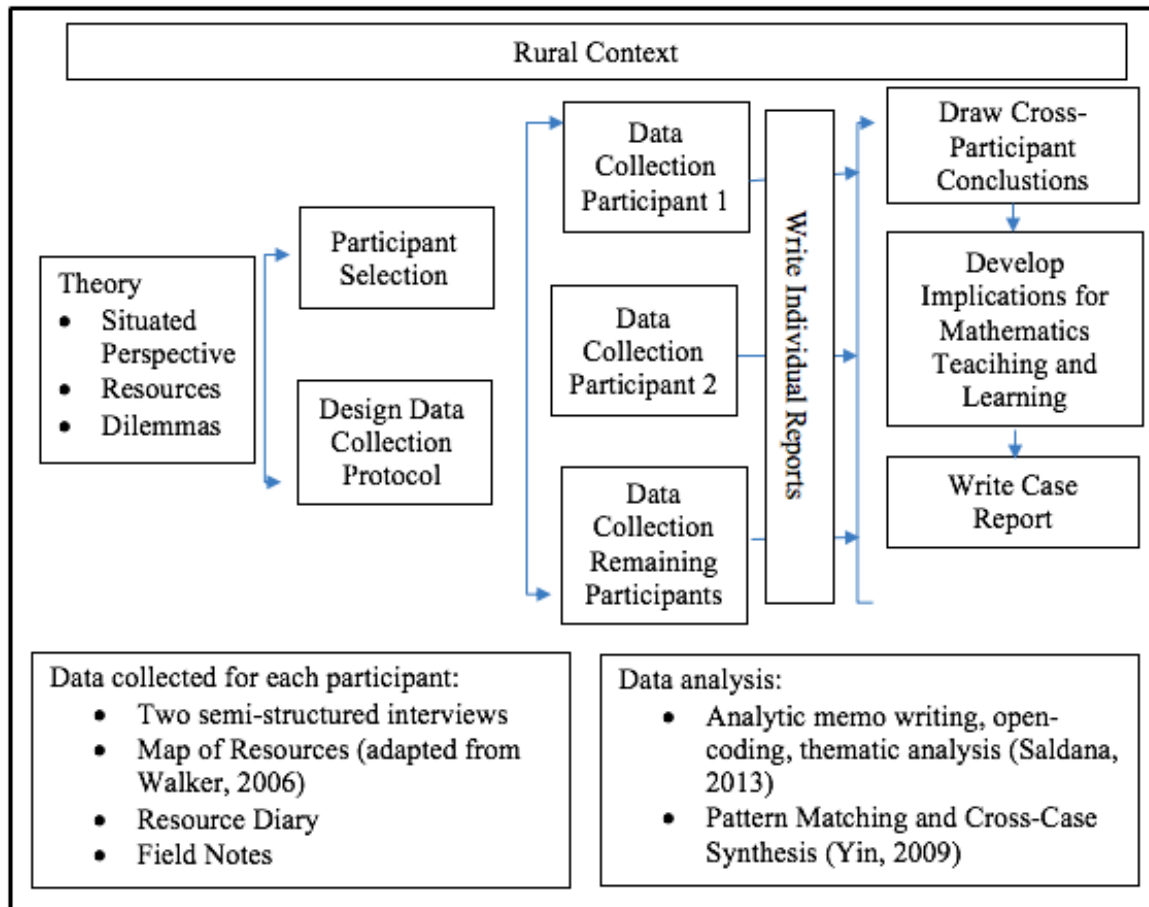


Figure 1. Overview of Study Design

assessments, approximately 60% of students grade 3-8 and 79% of high school students scored in the basic or below basic range for achievement. Issues within the district also persist around attendance, with the K-8 attendance rate of 94% and high school attendance rate of 90%.

Researcher's role. It is important to elaborate on my pre-existing relationship with the participants in this study. From 2015-18, I worked on project team of the MCP. In this role, I worked on a variety of projects that provided research-based professional development for K-12 teachers through weeks-long summer institutes and periodic follow-up during the school year. I have also collected teacher data from elementary and middle school mathematics teachers in the district. In addition to the professional development work and data collection, I have also supported these schools in building the capacity to host Family Math/STEM Nights in elementary and middle schools.

In my work and experiences with CCPS, I have developed reciprocal relationships with many teachers and stakeholders. These relationships have provided a foundation for collaboration and, in my time, I have noticed quality professional learning and growth in the teachers. Throughout our work with teachers in the county the conversations were richer, the connections to their local context became more meaningful, and the teacher-teacher collaboration was more noticeable. In addition, many of the teachers in the county did not attend or seek professional development regularly, as it was not a requirement from the district. These teachers were appreciative of the access to professional learning opportunities and few were also able to attend national mathematics teacher conferences due to funding from the MCP.

It is from my extensive work with this district that I take my role seriously. I was cautious not to leverage my relationship and put undue pressure on teachers to participate, and I carefully considered ways to inform teachers of the nature and scope of the study, assuring them that deciding not to participate would not affect our working relationship.

Participants

To gather the sample of participants for this case study, I utilized purposive sampling to gather participants that are rich with information (Flick, 2014; Patton, 2002) and which the opportunity to learn is of primary importance (Stake, 1995). This sampling procedure began with conducting this study within a district of which I had previously worked. I had a working relationship with many of the middle and high school mathematics teachers in this district through their participation in various professional development opportunities. A practical benefit of having a pre-established relationship is that the rapport assisted in mediating participant feelings of intimidation as they participated. It was my intent that the participants know that I am learning through and with them.

Furthermore, by aligning the participant selection with purposive sampling, I gathered five participants (Table 1) that represent maximal variation based on their experiences teaching mathematics—years of experience range from one to twenty-two and the five participants represent a mix of middle school, high school, special education, and general education. The use of five participants can be attributed to the recommendations that come with conducting qualitative case study research (Stake, 1995) and a situated perspective (Cobb & Bowers, 1999)—each of which do not

Table 1. Overview of Case Study Participants.

Participant	Middle or High School	Years of Experience	Courses Taught
Christa	High School	3	Geometry and Algebra II
Donald	High School	1	Algebra I and Algebra II
Kate	High School	4	Geometry Intervention
Judy	High School	22	Geometry and Algebra II
Sarah	Middle School	13	8 th Grade Mathematics

necessarily constitute the need for a more substantial sample as the participants context and perspective are integral to ascertain meaning. Additionally, this study gathered *good informants* (Morse, 1998) who have knowledge and experience, are able to reflect and articulate, and have time to participate. Having a variety of professional experience represented in the selection of good informants will allow for an understanding of dilemmas and resources at different times. After gaining approval from the County and the University of Tennessee's Institutional Review Board (reference UTK IRB-18-04774-XP), I met with principals from two middle schools and two high schools in the county. At this meeting I requested their advice for teachers whom I might ask to participate in this study. I described the criteria and focus of the study to the principals in hopes that each could lead me to a pool of potential participants who were personable, utilize resources to inform their work, and challenge themselves to grow as a teacher. While the criteria described previously represents the primary selection goals, attending

to a subset of criteria would suffice for secondary participant selection (e.g., the participant may have time to participate in the study but not be as knowledgeable or informative).

The data collection was bounded by five total participants from middle and high schools in the county; thus, I met with and invited the teachers to participate until the goal of five was met, asking each to sign an informed consent upon acceptance into the study (Appendix A). I selected five participants because of their varied years of experience, willingness to participate, and knowing that those asked were reflective teachers. This limited number of participants is supported by the work of Cobb and Bowers (1998), who suggest that the unit of analysis is not required to be large when taking a situated perspective. Others (e.g., Creswell & Poth, 2018; Flick, 2014; Stake, 1995; Yin, 2014) have also suggested a limited number of participants for case study is appropriate to meet the level of depth required for quality analysis and reporting.

By participating in the research study there was no direct immaterial benefits for participants; however, participants received three books about teaching and learning mathematics at the conclusion of the study, as payment for their time. In addition, if requested, or the conversation were to lend itself to it, I provided the participants with feedback after interviews and observations and offered resources to help mediate challenges emerging from our work.

Data Collection Procedures

A hallmark of case study research is that there are multiple sources of evidence used to understand a case within a bounded system (Stake, 1995; Yin, 2014); thus, this study utilized the concept of triangulation to provide systematic approach towards an in-

depth understanding of the participants perspective. Data were collected through interviews, observations, and written responses to provide a breadth of data within the case study database. The data were collected over a several-week period during the Fall of 2018 and early Spring of 2019.

Data sources. Research around teacher orientations, practices, and knowledge are critical to supporting teacher learning and professional growth. In their work describing methods to understand reform-based teacher practice, Borko and colleagues (Borko, Stetcher, Alonzo, Moncure, & McClam, 2005; Borko, Stecher, Martinez, Kuffner, Barnes, Arnold, Spencer, Creighton, & Gilbert, 2006) used the thinking of a scientist studying unfamiliar material to develop a *scoop notebook* teachers’ work—“just as scientists may scoop a sample of materials to take to their laboratories for analysis, [the authors] planned to ‘scoop’ materials from classrooms for [outside] analysis” (Borko et al., 2006, p. 4). A *scoop notebook* is described as a data collection method that gathers in-depth samples in a limited time period. For the notebook, teachers provide classroom materials generated prior, during, and after class (e.g., handouts, writing on the board, student work, and student homework), photos of the classroom layout and equipment, and a brief description of activities and reflection on the day’s lesson. In addition to the *scoop notebook*, Borko and colleagues conducted exit interviews about their experience with the data collection procedures, making note of ways in which the teachers’ practice could not be captured by the notebooks.

Just as Borko and colleagues (Borko et al., 2005; Borko et al., 2006) describe collecting scoops of data to understand teacher practice, this study utilized a modified, digital scoop notebook and interviews to collect “scoops” of data in order understand

teachers' conceptualization and use of resources to mediate dilemmas they experience.

The multiple sources of evidence that were collected in this study consisted of (1) resource diary (the modified, digital scoop notebook), (2) interviews, and (3) observations, of which each will be expanded on in the proceeding sections.

Resource diary. The purpose of the study is to understand how teachers conceptualize and utilize resources to mediate dilemmas; thus, it makes sense to collect self-report data from the participants. The resource diary (Appendix E) had areas for teachers to describe resources they made use of through a written description, uploading a document, and/or providing a web link. In addition to providing information describing a resource, participants were asked to provide the rationale for the resource use and description of how or why it was effective. This information will help better understand why the resource was sought out and how it supported the participant's work as a teacher. Participants were asked to complete the resource diary for three days in a two-week period; allowing flexibility in participation and respecting the time commitment teaching and being part of a study required. In addition, the resource diary was accessed through Google Forms to aid in the burden being placed on participants' time being part of the study. The data from the participants' resource diary were collected through Google Forms and organized in Google Sheets before being exported to Microsoft Excel for data analysis.

Further, Borko et al. (2005) found that collecting 'scoops' of data led to more meaningful reflection on teachers' work; thus, knowing the teachers are going to be filling out a resource diary could provide incentive for teachers' to think deeply about their work and how resources support the dilemma management aspect of teaching.

Observation field notes. Field notes are a common component to a case study database. The bulk of field notes were taken from observations of one period of mathematics instruction for each participant. Additional reflective field notes were compiled through interactions with participants and stakeholders throughout the study.

The purpose of using observational field notes of teachers' mathematics instruction was to take a critical eye into the field. As elaborated in Chapter one, teaching is a dynamic and complex task, field notes provide an outsider's perspective on the teacher's work, allowing me to allow me to make note of available resources and uncover resources that may be rendered invisible in the participants' practice. With this perspective I entered the teachers' classroom being mindful of resources and dilemmas these teachers' experience, seeking to understand features of access and experience in-practice-in-context.

Additionally, the field notes were collected through hand-written observations that were organized immediately after the observation and elaborated on in Microsoft Word. Appendix F shows the outline that was used to focus the observational field notes on resources and dilemmas.

Interviews. Two semi-structured interviews (Rubin & Rubin, 2012) occurred before and after participants completed the resource diary. The interview protocol used for the interviews can be found in Appendix B and Appendix C. Each interview was audiotaped and lasted no more than one-hour in length. The interviews encouraged discussion about topics related to about school mathematics (e.g., How would you describe the mathematics you teach?), resource conceptualization (e.g., Tell me about resources you find effective.), and dilemmas and resources (e.g., Tell me about a

dilemma you've experienced... What resources do you draw on to help you manage/cope with this dilemma?). However, the two interviews differed in two distinct ways.

The first interview acted as an introductory look at the teacher and their conceptualization of resources and experiences teaching. It is in this interview that I began to understand how the participants came to understand resources in their context. The focus was on what they had to say and how they came to think about resources to manage the dilemmas they experience in practice.

To further the conversation and focus the participants' thinking about resources, during the interview I asked each participant to complete the *Map of Resources* (Appendix D). The *Map of Resources* was adapted from the work of Walker (2006), who used the tool to understand pertinent resources students' felt influenced their success in mathematics. Taking this tool in the context of this study shifted the focus from the student to the teacher. Considering resources that helped one teach well from their perspective and providing opportunities to discuss items not included in the protocol.

The second interview occurred after the collection of the first interview, resource diary, and classroom-based observational field notes. This interview focused on the teachers making sense of resources they can access, resources they wish they could access, and aspects of resources the participants find effective in supporting their work. Specific follow-up questions were asked of the participants based on the field notes and the participants' resource diary.

Map of resources (adapted from Student Map of Influences on Mathematical Success; Walker, 2006). During the interview, the participant was asked to fill in four circles with resources they found effective. This was used to help prompt the participant

Table 2. Summary of Data Sources.

Data Source	Frequency	Description (Format)
Resource Diary	Participants contributed to a resource diary three times over the 2-week data collection period	Participants made note of the resources utilized before, during, and after one period of instruction and provided a rationale for using the resource and its effectiveness to mediate dilemmas (Appendix E). (Microsoft Excel)
Interview	Participants were interviewed once prior to the data collection period and again at the conclusion of data collection.	Participants responded to questions stemming from the interview protocol (Appendix B, Appendix C). Participants also completed the graphic organizer (Appendix D) in the second interview. (Audio, Microsoft Word)
Observation Field Notes	One class-period observed during data collection period. Periodic reflective notes were recorded after interactions with participants.	Field notes were recorded during the class period with special attention to the availability of resources and resource-use during instruction. Notes were collected reflecting interactions with participants and about the school (from entering, walking to the room, and exiting) for purposes of providing additional context. (Microsoft Word)

during interviews and better understand their rational for selecting particular resources to bring up. Additionally, in the second interview we recalled the *Map of Resources* and reflected on the concept more broadly.

Summary. Table 2 provides an overview of the data collected. Together these data sources formed the database for the case study analysis. As the data were collected it was organized and initial analyses (e.g., familiarizing myself with the data, analytic memo writing) took place. The data analysis procedures are described in the following section.

Data Analysis Procedures

The data analysis process taken up in this study is both complex and extensive. The works of Stake (1995), Yin (2014), Saldaña (2013) and Creswell and Poth (2018) served as the essential texts employed to inform and carry out the methodological decision making behind this data analysis process. Stake (1995) worked as the main text that informed my framing and approach to the case study analysis. In his work, Stake places emphasis on the need to *understand* a case—rather than explain away—and provides a dimension to this study by outlining analyses and ways of thinking focused on understanding (e.g., direct interpretation and categorical aggregation). In addition, Stake informed how to go about thinking through triangulation throughout the data analysis process. Though Stake’s work was relevant throughout the analysis, it was particularly useful in individual case analyses, it was the work of Yin (2014) that better informed looking across cases. Though Yin’s (2014) work is more aligned with case study research that works in the field of program evaluation, his descriptions of pattern matching and cross-case synthesis were used here to better inform the cross-case analyses

taken up in this study. Additionally, it was previously mentioned that Saldaña (2013) is an essential text that informed the analysis taken up in this study. In general, Saldaña's (2013) work was used to inform decision making about coding techniques and as a reference for purposeful memo writing and coding organization.

Finally, it is important to note that though many discuss the usefulness of applying data analysis software to aid in the analysis process (Creswell & Poth, 2018; Flick, 2018; Rossman & Rallis, 2012), I did not feel comfortable using this acquired approach given the timing of the study. I also found that a more hands-on, intimate approach to analyzing and working with the data allowed me to further familiarize and immerse myself in the analysis.

The following sections described the data analysis process of organizing, familiarizing and analytic memo writing, interpreting and representing the codes into analytic themes, and looking within and across cases.

Organizing the data. As the data were collected it was sorted into folders for each participant. Each folder included the interview audio, an Excel spreadsheet with the participants' data from the resource diary, and Word documents for each interview audio transcript (two documents total), and thick description of classroom observation field notes (one document). The data in each folder were also printed for convenience and ease of use.

Familiarizing self with the data. In familiarizing myself with the data, I conducted an initial reading of each data source prior to rigorous analysis. While reading, I wrote analytic memos, hunches, and brief notes of inspiration in the margins (Merriam, 2009). After the initial read, I allowed a period of time to pass for the data to

incubate (Rossman and Rallis, 2012), taking time to go for a run and/or walk my dog. This incubation period allowed me to process the initial read and run an abstract analysis without the data in front of me. Returning from the run/walk I jotted down terms I felt could develop into codes and themes to begin the analysis process; Creswell and Poth (2018) describes these as *lean codes* that will be expanded, discarded, and utilized in follow-up readings of the data.

Describing and classifying data into codes and themes. Each participants' data went through at least three coding phases. In the initial coding phase *in vivo* and descriptive codes (Saldaña, 2013) were employed to take a *grand tour* of the interview and resource diary data (this is after the initial incubation period, considered phase zero). These coding methods were used to keep the analysis as closely rooted in the participants' voices and language as possible. Descriptive codes sought to summarize data by identifying the topic, not necessarily the content; *in vivo* codes allowed for the participants' language to stay at the forefront as descriptions were being used to make references across data. Using multiple data sources for each participant allowed for cross-referencing and infer initial meanings and understandings of how their voice describes resources and resources as mediators of dilemmas. In addition, concept coding was used to first analyze the thick descriptions to better understand the big picture ideas suggested by the data (Saldaña, 2013). This coding method allowed for a single word or phrase to provide imaging of the larger picture within the data. Together the *in vivo*, descriptive, and concept codes afforded my initial understandings of the data to show while also considering the participants' voices as critical to inferring meaning in context.

The second phase was focused coding (Saldaña, 2013), as it lends itself to enable the researcher to “compare newly constructed codes during this cycle across other participants’ data to assess comparability and transferability” (p. 243). Focused coding also supports the integration of *in vivo* coding with other methods to categorize the data into themes. It is in the second phase that a search for the most significant codes will be gathered and connected to create salient categories that describe the dataset. It is important to note here that categories analyzed from the data can lack sharp boundaries that support different degrees of belonging. An additional phase of iterative coding and categorizing was completed because the database still appeared disjoint and themes inadequately represented at this point in the study.

Finally, Saldaña (2013) describes how “sometimes we become overwhelmed by the magnitude of our studies and thus need to intentionally focus the parameters of our investigation in progress to find its core” (p. 274). To remedy this dilemma, I employed the *top 10* strategy for each theme. A focusing strategy that was used here was *the top 10 strategy*, where one takes often expansive categories and forces a limit on the number of ideas that have been developed. Here, regardless of the codes within each category, no more than 10 quotes or passages from the dataset will be used to describe the category. These representative quotes/passages will be collected in one document and arranged to best describe how category is being understood. This focusing technique helped simplify the data and supported the transition to writing the case study report.

Another aspect of the description and classification of data process is that of memo writing. Memo writing occurred throughout the data analysis process (from incubation to focus phases) and is similar to that of journaling. I made conversational

notes about the data analysis process that provided opportunities to make note of analytical, reflective, and descriptive observations of the dataset. Additionally, memo writing allowed me to keep a record of my decision making throughout the data analysis process.

Finally, in taking up these rounds of coding, Stake (1995) discusses elements of direct interpretation and categorical aggregation. Here, direct interpretation was used to understand dilemmas, where codes were defined and redefined over time. Additionally, categorical aggregation was used to understand resources, where codes captured instances that could later be talked about as a class or group.

Interpreting the data. Having the data in a focused representation of potential categories and themes allowed for a thematic interpretation of the data. Here, I utilized my *top 10* results and memo writing to create descriptions for each theme in context. After having a clear definition of each theme, I looked for patterns that describe how teachers conceptualize resources and utilize resources to manage dilemmas they experience—Rossman and Rallis (2012) describe this step as organizing themes into a larger abstraction and Yin (2014) describes these actions when discussing tenants of pattern matching and cross-case synthesis. This process involved looking across participants and themes to find ways to report a descriptive interpretation. In addition, the research sub-questions provided a foundation to make synthesis across participants and offer opportunities for pattern matching (Yin, 2014).

Creating a visual representation and member checking. The final step in the analysis process was using the interpretation to create a visual representation of the data. Here I found a means to visually show the rural mathematics teachers' conceptualization

of resources and propose significant vignettes of teachers' use of resources to mediate dilemmas. These representations supported the reporting of conclusions and implications for teacher education and mathematics education research on teachers, resources, and dilemmas.

Summary. Together the stages of data analysis encompassed analytic memo writing, open coding, and thematic analysis of the interviews, map of resources, field notes, and resource diary to answer the overarching research question for this study. Table 3 summarizes the data analysis methods applied to each data source.

Methodological Issues

For many, case study takes on a narrow focus and lacks generalizability. Although it is true that outside of the five participants in this study other teacher experiences and classrooms are unknown, this study provides a deep look into the relationship between teacher and resource. This case study also assisted in the search for patterns in practice and addresses the limitations that can come from a decontextualized and presumptive quantitative or mixed methods survey. Additionally, the employment of triangulation between the various data sources at different points in time, place, and persons, allowed for a surplus of knowledge to be generated at different levels. This multi-level and multi-participant plunge into the teachers' perspective allowed for insights to extend beyond the knowledge made possible by one approach and increases the quality of research (Flick, 2014). The data collection and triangulation within the study provided an opportunity to develop better explanations for differences between participants. Finally, this study is positioned to act as a pilot for a series of future studies that investigate the relationship between teacher, resource, and dilemmas of practice.

Table 3. Summary of Data Sources and Analysis.

Data Source	Method of Analysis (Saldaña, 2013)
Resource Diary	<i>In vivo</i> and descriptive coding, focused coding, <i>top 10</i> focus strategy, memo writing
Interview (including <i>Map of Resources</i>)	<i>In vivo</i> and descriptive coding, focused coding, <i>top 10</i> focus strategy, memo writing
Observation Field Notes	Concept coding, focus coding, <i>top 10</i> focus strategy, memo writing

Summary

The preceding sections described the data collection and analysis procedures for the dissertation research. Figure 1 provides an overview of the case study, highlighting major steps in the research process. The following chapter consists of the insights gained from the data analysis.

CHAPTER FOUR

INSIGHTS GAINED

The analysis for this study is focused on understanding the following research question: *How do mathematics teachers in rural settings make use of resources to mediate and manage dilemmas in practice?* To help unravel this question two sub-questions were formed to help guide the analysis:

1. From the teachers' perspective, what are the dilemmas of practice that mathematics teachers in a rural setting experience?
2. How do mathematics teachers in rural settings conceptualize resources for the teaching and learning of mathematics?

This chapter provides the findings with respect to the study questions. In the first five sections, individual descriptions of the findings are provided for each of the rural secondary mathematics teachers. Each individual description begins with an introduction to the teacher and is followed by findings related to (1) their perspective of dilemmas they experience, (2) their conceptualization of resources for teaching and learning mathematics, and (3) the mediating role of resources in their management of dilemmas. Finally, summaries are provided at the conclusion of individual description. The sixth section of this chapter provides the findings from a cross-case analysis that looks across the five rural secondary mathematics teachers. The cross-case analysis explores commonalities and significant differences between the individual and group are highlighted in relation to the research question and sub-questions that guide this study. Finally, the key findings are related back to the research question and sub-questions in a summary of Chapter 4.

Teacher #1: Sarah

I first met Sarah in 2015, while conducting K-8 professional development sessions in Wagon Wheel Schools. In the professional development sessions, I remember Sarah attending to the norms the project team intended to cultivate with the group of teachers—participate with an open mind and ask questions. In addition, she was a teacher who relied on her personal teaching experience to inform her contributions to discussions during sessions. Knowing this about Sarah made her an ideal participant for this study—a reflective thinker and life-long learner.

At the time of the study, Sarah was in the middle of her first-year teaching eighth grade mathematics at Mountain Range Middle School and completing her thirteenth year of teaching in Wagon Wheel Schools. Her previous twelve years of experience consist of teaching in both elementary and middle school settings, most recently teaching seventh grade mathematics. The wide range of teaching experience has led Sarah to teach mathematics with an emphasis on its connectedness across the schooling progression. As she puts it, “I try to teach them that it all just builds on each other, that everything keeps going.” Students cannot say that they were not taught something because Sarah was probably the one who taught them the material—this is particularly relevant given that she moved from teaching seventh to eighth grade this school year and is teaching many of the same students. The interviews, resource diaries, and observation provided insight to her views and experiences teaching and provide the foundation for the following sections that illustrate how Sarah describes dilemmatic situations, conceptualizes resources, and how the resources she describes act as mediators for the dilemmas she experiences.

Dilemmas. Three categories highlight the dilemmas Sarah encounters in her practice—the dilemma of choosing curriculum materials, the dilemma of control, and the dilemma of ambitious teaching.

The dilemma of choosing curriculum materials. Throughout the study Sarah showed evidence of experiencing dilemmas when having to make decisions about curriculum and instruction in her planning. On one hand she has items provided for her as appropriate curriculum materials, as determined by her district and state (e.g., the textbook from her district and materials located on the state website). However, the materials she is provided do not meet her expectations for classroom instruction, based on her understanding of the rigor of the current state standards and assessments. As Sarah describes it, “I look for what I can use out of the book. I really don’t like our books, so I don’t use them a lot.” By not feeling confident in the veracity and rigor of the textbook, Sarah is faced with a problematic situation—what materials do I use to teach the standards and how do I make those choices?

Sarah also describes how the district recently started a system-wide Response to Intervention (RTI) program with little to no material or training support for teachers. This experience places Sarah and her colleagues in a situation where they have to:

Pull in kids that we, you know, that based on benchmarks they need that extra help. But we have no set materials to use, you just kind of figure out what they need work on, and you work on it. You know, that's not really what RTI is, you should have a, it's gotta be, you know, data driven.

A lack of approved materials and procedures has created a problematic situation where Sarah and her colleagues are wondering how do to go about effectively implementing

RTI at their school? This has become relevant as Sarah describes how she believes in the underlying intent of RTI, while at the same time being told that RTI is not reteaching by her school administration. However, Sarah and her colleagues find themselves planning for RTI and saying, “Oh, okay yeah, we've done this, and they struggled with it, so let's reteach it.”

The dilemma of control. Sarah describes encountering problematic situations that relate to control in two regards—classroom assessment and participating in a professional learning community (PLC). In terms of classroom assessment, Sarah describes how this year the district is requiring all teachers to post three graded assignments per week for each class. This mandate has created a tension in her practice where her assessment practices do not line up with that of the district. She says:

I know if [the student’s master the material], but it doesn't always reflect [how the district wants it to] ... So, you know, I'm having to come up with more stuff to take grades on because a lot of times I'd only get one or two grades a week, because I did a lot of stuff in class, you know? That was my, that was my assessment in class that guided, you know, whether I could move on or not. But now they're wanting it more documented, I guess. So, I guess that's the struggle with me is I have to remember that I have to give them more to document so that I'm coming up with those three grades a week.

She describes her assessment practices as game like and more informal/ungraded that help guide her instructional decision making. Often feeling that when she puts things like games under assessment on a lesson plan turned in for an evaluation, the evaluator looks at it and thinks, “Well they’re just doin’ games in there.” As she is conscious of the

situation, she finds herself struggling to find an answer that aligns with her teaching and still meets the mandate from the district.

The idea of lacking control over professional decision making was also revealed when Sarah discussed attending PLC meetings. She describes:

We have PLC... we have a math [teacher] from each grade level and... we have a form that we have to fill out. We do the best we can to fill out that form for each meeting. Last year it was the same form, same thing... the focus is more on making sure that that form is filled out and it sounds good, more than we're actually getting anything accomplished in the PLCs.

Similar to her experiences with RTI, Sarah feels that this is another program that is not reaching its full potential. In her view, PLC should act as a place where teachers can help each other to, “better our schools and better our content area,” by way of focused change. However, when the expectation is that the PLC participants “fill in a paper professionally,” it creates a tension and problematic situation where Sarah’s behavior and consciousness exist in conflict.

The dilemma of ambitious teaching. In describing dilemmas related to ambitious teaching, Sarah talks about having a desire for rigorous and engaging instruction that uses technology, but often finds herself being “old school” and lacking confidence in students’ ability. First, Sarah showed that she lives with contradiction when thinking about technology integration with classroom instruction. She says:

Typically, I write notes, I do problems on the board. And when we are doing something like [graphing linear equations] and we can use [the document camera or interactive whiteboard], I do. But, um, it's funny, I've not taught, this is only

my 13th year, but I'm still, I still have an old school mentality about it. There's something to be said about practice, practice, practice. You know, I try not to overkill, but there's something to be said about that. You know, technology isn't everything. So, I use my whiteboards a lot. I'm very old school.

Sarah also describes her hesitation with technology integration due to faulty internet reliability and an unpredictable mobile lab that “sometimes works and sometimes doesn’t.” She believes that there are good programs available for students to use and would enhance student learning, but often has to look the other way and find something more practical to use for classroom instruction. Thus, though Sarah wants to enhance her instruction with technology, she is experiencing a dilemma where she is unsure if the underlying materials are reliable for her instruction to even be effective.

Sarah also describes having a lack of confidence in student ability when planning and teaching that impacts her decision making. For instance, Sarah describes how she has to consider if activities will “go over [student’s] heads” and believes that to teach she needs to “keep all them in their seats quiet or [she] lose[s] them. So, it's rare that they do partner work.” She describes this experience in two other passages. First, where she says another teacher is letting their class collect their data and while she thought about doing the same thing, but she said:

I did not. And the kids were like, ‘You should let us.’ And I'm like, ‘Yeah, I chose not to,’ because I have a class that if I, if you give them an inch, they take a mile and we wouldn't have gotten data that was accurate because we would have been playin' the whole time.

Second, where she frequently talks about her students in ways similar to, “The sad thing is, is that in eighth grade, they don’t [know multiplication and division] ... and I don’t let them use a calculator.”

Resources. Five categories distinguish Sarah’s conceptualization of resources for the teaching and learning of mathematics: dispositions, relationships, knowledge, curriculum materials, and school materials.

Dispositions. In talking about dispositions as a resource, Sarah described two subcategories—*patience* and *desire for students to learn*. In describing patience, Sarah said, “Patience is something you never pray for or you’ll never get it. Patience to me is knowing that students A may get it today and student B may not get it until two weeks down the road.” She finds patience to be a significant resource as it is something tangible to her that allows her to “find ways to help students be successful so that it starts clicking and they don’t shut down.”

Sarah also describes having a desire for students to learn in a similar but different way. As a resource, having a desire for student success is something that helps to motivate students to work in her class. She describes always telling students that, “I’m not here to be their friend. I’m not here to fail them. I’m not here to pass them. But if you don’t want to try, I don’t care to give you the F, I would much rather you succeed though, you know?” She uses this desire for students to succeed as a resource that helps “make sure students are staying on task” and helps students “know they’re successful in what they’ve done.”

Relationships. When describing relationships as a resource, Sarah’s data were placed in three sub- categories: relationships with students, relationships with families and the community, and relationships with peers.

First, her relationships with students helps inform her inform instructional decision making and curriculum adaptations by way of cultivating a knowledge of students through said relationships. These relationships with students are exemplified as a critical resource when she is describing how relationships with students also helps cultivate a sense of caring from the teacher to the student. As she says:

If you don't [have a relationship with them], if the kids don't think you care, they don't care. And if they, if they know that you care about them, they are going to try harder. They're also going to be more open to ask questions and to, you know, they'll be more open to asking for help and knowing that you're, that you're here for them, not just for that paycheck. I think you have to have relationships with your students.

She also talks about a lot of teaching going back to having relationships as a critical resource to do her job, “You have to know who you’re teaching, so you know how to introduce something that makes sense to them... and a lot of it goes back to the relationship with the students.” Her focus on relationships in the classroom that are teacher-student was also noticed during her observation, as much of the classroom discourse was focused around teacher and student interactions.

In talking about relationships with families and community, Sarah discussed having a knowledge about what is going on inside students’ families and a general pulse on student interests. As she puts it, “You know whose parents were at home last night,

whose were in jail, who was at work, you [figure out] what can we, what can we relate things to.” Here, she is describing relationships as if they act as a resource for her to further her cultural and sociocultural knowledge and understandings to apply to her work in the teaching and learning of mathematics.

The third subcategory of relationships are those with colleagues. Sarah frequently mentions both current and former colleagues as resources for her when planning and teaching mathematics, including her time meeting with colleagues in PLCs. For instance, when noticing discrepancies between the state standards and textbook, Sarah talked about engaging with the other eighth grade mathematics teacher, Zach, as a resource. She also views teachers who have retired, moved, or work in another school, with whom she had worked with prior, as a resource when she is planning and reflecting on mathematics instruction. This marks a distinguishing factor within this subcategory where, in contrast to turning to Zach, Sarah frequently talks about texting and emailing a more experienced teacher to ask questions about mathematics teaching and learning. This is unique as she finds herself saying

And that sounds like I don't have confidence in Zach. I do have confidence in him. I just, Julia and I are friends and I know Julia's taught longer you know, she's taught the same amount of time as I have, but, and Zach hasn't taught as long as the both of us have. So, it's not that I don't have confidence in him, I just will, I would rather ask a more seasoned teacher... So, I tend to want the more seasoned teachers' advice, not necessarily, you know, he might have more years in the grade, but he doesn't have more years in following the standards and looking at them and all of that.

Knowledge. Sarah describes knowledge as a resource in three ways—student content knowledge, teacher content knowledge, and experiential knowledge. First, she talks about student knowledge in terms of their prior content knowledge, or at least knowing, “the basic concepts,” and having, “a basic foundation.” Sarah considers this prior, basic knowledge as a resource that allows her to move students forward in her class. However, her experiences teaching has led to a lack of confidence in students’ abilities to perform the basic concepts. This is exemplified when Sarah talks about students not coming to her classroom with multiplication and division fluency, as she says “I don’t have time to go back and reteach multiplication, and multiplication and division are in everything that we do. ‘Cause proportions, anything is cross product and dividing. So, they have to know how to multiply and divide!” Students prior knowledge was also observed as a relevant resource that Sarah uses while she is teaching, where she is constantly referencing content students have experience with and to make connections.

When talking about teacher content knowledge, Sarah holds this resource in high regard. “I’m here to impart that knowledge,” she says, “and if I don’t have it, I can’t impart it.” For Sarah, content knowledge is a critical resource for her to do her job effectively. She also believes that her vast experiences teaching mathematics have afforded her a perspective on the mathematics curriculum that allow her to make connections between grade-level content. In addition, when she does not believe she has the appropriate content knowledge she says she is “willing to look things up” and “study,” using her relationships, textbook, and the internet, to be prepared to teach a class. ‘

Finally, when Sarah uses her experiences being a student herself, teaching elementary and middle school, and tutoring K-12 students as a knowledge bases that can be drawn on for in the moment teaching. This can be exemplified when Sarah is talking about her experiences with her own children and teaching experience to comment on effective instruction:

You can't just come in here and know [mathematics] and teach it. That doesn't work. I've seen so many, my kids have had so many teachers in the past that knew their math but had no idea how to share it and teach them, you know? And we're going through that now with my daughter in high school. The teacher, she has a smart, knows what they're doing, but has no idea how to break it down and make sure that the students are getting it, you know? So, I, you have to, you have to put it all together [when I'm teaching]. It can't just be one thing. You can't just say, I'm a math major and I can teach math. Can't necessarily teach it, you know? Um, you have to know what you're doing. You have to, you have to know the audience so that you can relate to them and give them the information they need.

Another way Sarah talks about using experiential knowledge as a resource is when she is talking about making decisions about content to cover during RTI. She says:

So, what I do with the kids that I have is I know what skills the average eighth grader struggles with, integers, exponent rules, stuff like that, whatever we're working on in class, if it's given them a hard time. And I just used that, you know, I just find, go back and find, um, simpler stuff.

When talking about knowing what the, “average eighth grader struggles with,” Sarah is making a statement that is a culmination of her teaching experiences and interactions

with peers. This is critical as we might often view this as a result of something like educational coursework, but as Sarah states, “I didn't take math for elementary teachers,” in college; rather her mathematics education coursework was supplemented with upper-level mathematics content courses, because, as an undergraduate student, Sarah switched from majoring in mathematics to education.

Curriculum materials. In terms of her work as a teacher of mathematics, Sarah talks about curriculum materials as both hands-on and virtual curriculum materials. Hands-on curriculum materials include grade-level state standards, textbooks, both current and previously used versions, and sample state end of course exams. These resources are often critiqued by Sarah as disjoint or lacking a sense of continuity.

Given the disjointedness of the hands-on curriculum materials, Sarah has found herself exploring virtual curriculum materials on the internet. This is largely done through a Google search of a content standard or topic and finding a worksheet. She has also found herself revisiting many websites that host virtual curriculum materials. For instance, Sarah discussed using Teachers Pay Teachers and state education sites, like Engage New York, Tennessee Ready, and Louisiana Believes, as her main source of virtual curriculum materials.

School materials. When discussing school materials there were two sub-categories Sarah discussed—basic school materials and school mathematics materials. In terms of basic school materials, Sara discussed technology. She describes using her interactive whiteboard, laptop, the school-based internet, a mobile lab, and a newly acquired document camera in her practice. But as she said, “You know, technology isn't

everything. So, I use my whiteboards a lot. I'm very old school.” She also has students use poster board and keep up with math journals.

For school mathematics materials, Sarah discussed using calculators, though she only received a class set of uniform calculators this year, and her make-shift dry-erase whiteboards with grid paper. Additionally, the Common Core Mathematics Practice Standards are posted around the room along with a bulletin board dedicated to supporting students’ “math talk” by providing sentence- and word-stems.

Resources as mediators of dilemmas. Sarah’s conceptualized resources—dispositions, relationships, knowledge, curriculum materials, and school materials—each play a mediating role in the dilemmas she experiences—the dilemma of choosing curriculum materials, the dilemma of control, and the dilemma of ambitious teaching. Findings on the role of Sarah’s resources as mediators of dilemmas she experiences is explored in the following sections.

Mediating the dilemma of choosing curriculum materials. By having a lack of confidence in the curriculum materials (textbook) provided by the district, to meet the rigor and expectations of the state standards, Sarah finds herself in a situation where she believes she needs to look elsewhere for curriculum materials to use in class. In making choices about new curriculum materials, Sarah draws on the following resources: virtual curriculum materials, teacher content knowledge, experiential knowledge, relationships with students and students’ content knowledge. Though she finds herself lacking confidence in the textbook, she does begin planning and thinking about what curriculum materials to use in the classroom by first looking “for what [she] can use out of the [text]book.” She does this in conjunction with looking at her standards and pacing guide,

while considering her content knowledge. Sarah then says that she goes to the internet to search virtual curriculum materials, particularly state websites and conducting a Google search, to see how the standard should be explained to students. As she is perusing various virtual curriculum materials, she is also drawing on experiential knowledge, students' content knowledge, and relationships with students and the community, as resources to mediate this dilemma. This process of making decisions about appropriate curriculum materials is best described by Sarah when she says:

If you go to Louisiana Believes, it's got their standards and has good examples that go with that standard, and [this state] has done that on our power standards but not on all of our standards. So I can look at some of that on [a state website] that I can look at some of it on the Louisiana and then I just start Googling what, like I'm teaching line of best fit, so I just Google that until I find something on there and then I see if it's, you know, if it relative to what we're doing, is it over their heads? Is it something they can do? Will this data make sense to them? Can we use this data?

Sometimes, Sarah finds herself in agreement with the textbook and feels that it represents the standards appropriately. However, she describes a moment when this happened that created a tension when she went to teach addition and subtraction of numbers in scientific notation. In response, Sarah talks about turning to her relationships with colleagues as a resource to mediate this problematic situation. For instance, when her lesson on adding and subtracting values in scientific notation did not go as planned, she describes looking at the standards and textbook and first thinking, "Oh, okay, I get this," but when teaching using her textbook she did not feel as though she was explaining

it in a way that made sense to the students. She describes how she felt that she was giving the students “too many choices and so that confused them.” This experience caused her to reach out by text to a former colleague who had taught eighth grade mathematics and also to the other eighth grade mathematics teacher in her school. After reaching out she found that the tension created in this situation was mediated by her colleagues, both former and current, who shared alternative strategies for teaching the content and she was able to return to her class and say, "Okay, this was my fault. I confused you all. So, we're just going to keep what we have in our notes, but we're going to add to it and we're going to go back over this.” She then talked about how students began to understand how to perform operations with numbers in scientific notation, a dilemma mediated by her relationships.

In terms of mediating the dilemma of not having training or materials for RTI and still being expected to implement the program, Sarah relies on relationships and knowledge to mediate the dilemma. She describes drawing on her relationship with colleagues to figure out what content the students may need help with, while also drawing on her experiential and content knowledge that helps her understand what content may be relevant. As she describes it, “Oh, okay, yeah, we've done this and they struggled with it, so let's reteach it,” and, “So what I do with the ones that I have is I know what skills the average eighth grader struggles with, integers, exponent rules, stuff like that, whatever we're working on in class, if it's given them a hard time. And I just used that, you know, I just find, go back and find, um, simpler stuff.”

Mediating the dilemma of control. There are two ways that Sarah describes encountering dilemmatic situations with regards to control, and in each she is being told

to do something without having guidance, training, or support on how it should be accomplished. First is control over assessments. For Sarah, her conceptualization of assessment is one that differs from that being mandated by the district (i.e., having to put in three graded assessments per week). Sarah believes that content related games she plays in class and questioning act as ways for her to know if her students are understanding and are, “ready to move on,” or, “not ready to move on.” These assessments are often ungraded, but still act as an assessment to inform her instruction. When tasked with having to have three graded assessments per week, Sarah was unsure how to make this work. She turned to her experiential knowledge and decided to have daily quizzes or work taken up each day. In addition, she drew on virtual curriculum materials, in the form of downloadable worksheets, to have things for students to do in class. As she faced a situation where she felt like she was forced to have, “graded assessments,” that exist in contradiction to what she is thinks of as appropriate assessments, her experience was mediated by using the internet to find virtual curriculum materials and drawing on past experiences. 3

Second is control over participation in a professional learning community. This dilemma of participating in a PLC that is focused on a filling out a form created a tension with respect to the purpose of the PLC beyond just “filling out the form professionally.” This passage from an interview describes her experience:

I still feel like the focus is more on making sure that that form is filled out and it sounds good, more than we're actually getting anything accomplished in the PLCs. Um, whenever I would try to ask questions or talk in PLC last year, it was like I got brushed off, eyes rolled at me. "Oh, we don't really need to do this.

Let's just fill out this paper." This year, I've just taken that, that same stance. I'm like, "Okay, nobody really wants to be here. Nobody really wants to do this. Let's just do what we gotta do and go on," and so I'm not making it any better.

This tension was not readily mediated by anything other than the relationships she had with her colleagues. Though she discusses how she is usually brushed off when bringing up relevant topics, in favor of thinking about the form, she does mention that she is sometimes able to draw on her relationships with colleagues to make the best of their time. As she explains, "But stuff like [sharing teaching experiences] is kind of where we help, help each other out. Um, you know, if we're teaching something and they're struggling with it, what are some strategies that we did that we changed, that we tried, that worked and didn't work." While not being the norm, Sarah does share how there are times where relationships with peers and content and experiential knowledge are used to mediate this dilemma. However, she does still think that the department need more training and guidance from their administration for PLCs to be effective in how she believes they can be.

Mediating the dilemma of ambitious teaching. Sarah is conscious of how basic school materials, like technology, can enhance one's instruction and has a desire to integrate this in her teaching practice. However, often her actions in the moment are in contradiction with what she knows and believes about the teaching and learning of mathematics. This is not an easy dilemma for Sarah to grapple with, as she often uses phrases like, "I wish," and, "I know it could, but..." to describe her coming to terms with her actions. For instance, resources like school-based internet access, a mobile lab, and interactive whiteboards should be tools of which she has access to integrate in her

instruction, but her experiences using the technology she has available has left her thinking that the mobile lab, “sometimes works and sometimes it doesn’t,” that the school needs, “better internet service with more access,” and that her interactive whiteboard goes out, “every time you open [or close] the [classroom] door.” Having faulty issues with technology has forced her to mediate this dilemma with non-technology basic school materials. For instance, Sarah talks about knowing that there are great computer programs she can use to support her teaching topics like Geometry but relies on hands-on manipulatives, math journals, and worksheets, due to the unreliability of the technology that is available. In addition, she relies on her whiteboards in place of her faulty interactive whiteboard, while constantly attempting to blend the two as much as possible. These materials mediate the dilemma of using technology for ambitious teaching, but Sarah still feels that her teaching is high-quality and rigorous with the alternate materials.

Sarah also experiences the dilemma of ambitious teaching as she often notices a tension between curriculum material expectations and her confidence in students’ abilities. This is noticed as she wonders if content will “go over [students’] heads” as she is deciding what and how to teach. While knowing there may be a different and more ambitious way to teach a particular topic, Sarah often finds herself thinking drawing on her experiential knowledge and dispositional desire for students to succeed. This is evident when Sarah talks about her desire for to create situations for all students to “be successful” and when she draws on previous teaching experiences with students to inform and come to terms with what she will do with her current class of students. This dilemma of ambitious teaching and confidence in students’ abilities is not just mediated by Sarah’s experiential knowledge and dispositions, but also by the relationships she has with her

peers and students. As she found herself feeling like she gave students', "too many choices... that confused them," and after talking with colleagues she decided to teach them to, "always go to the larger exponent." In addition, as Sarah was thinking about having her class collect their own data for a series of lessons, she decided not to do it because her relationship with the students led her to think that, "If you give them an inch, they take a mile and we wouldn't have gotten data that was accurate because we would have been playin' the whole time." She knows this is a "great ideal," but thinks that she, "could have done it with one of my classes, but not all of my classes. And it's not because a student management ... it's just because they're who they are, and I know how they are." Thus, for Sarah, this aspect of having a dilemma of ambitious teaching is being mediated by her experiential knowledge, dispositions, and relationships with both peer's and student's. These resources help her come to terms with her actions and feel comfortable teaching her classes each day.

Summary. Sarah's conceptualization of resources and description of dilemmatic situations illustrate a teacher who uses virtual curriculum materials, relationships, non-technological school materials, and knowledge as primary resources to mediate the dilemmas she experiences. It is also apparent that her desire for students to succeed acts as a motivating resource that she draws on to get herself to reach out to colleagues, search the internet, and get to know students to inform her decision-making and practice. Figure 2 summarizes the mediating relationships resources have with the dilemmas Sarah experiences and the decisions she makes in-context-in-practice that were laid out in her individual description.

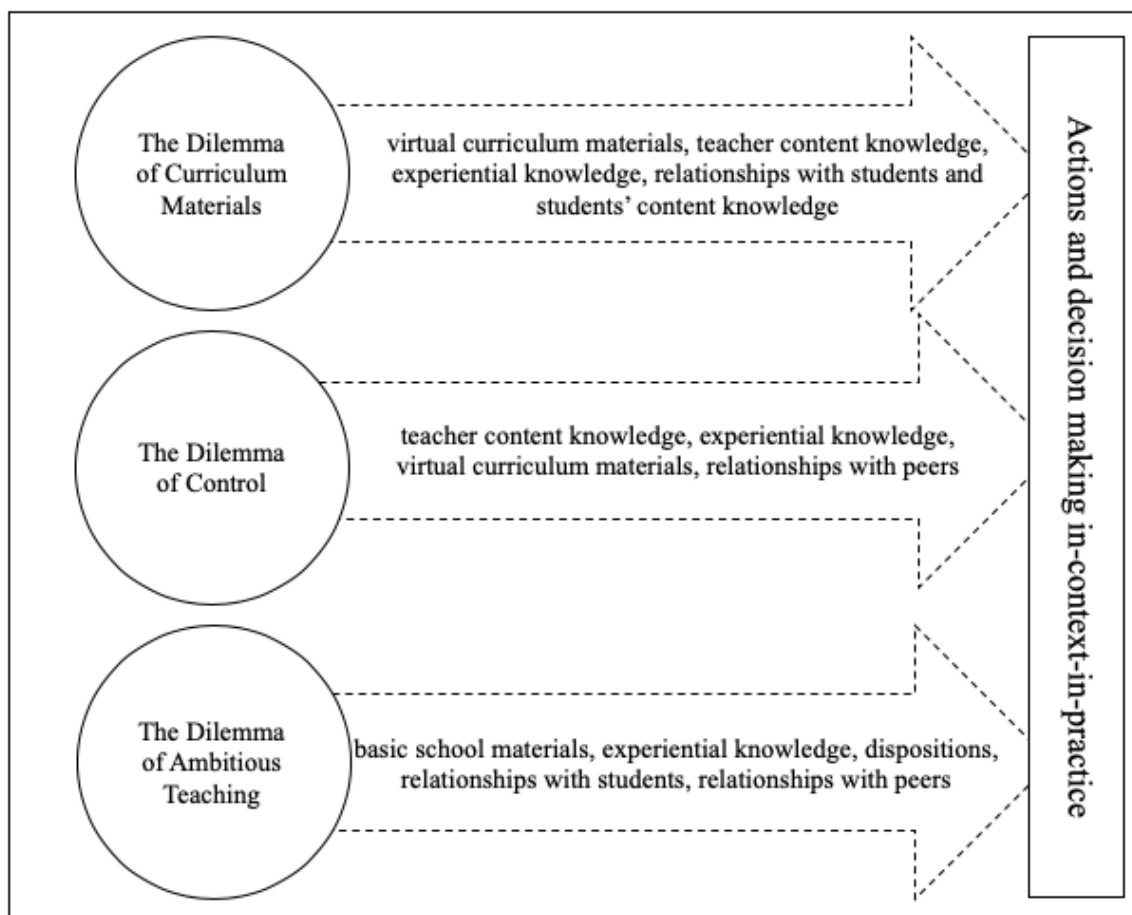


Figure 2. Overview of Sarah's resources mediating dilemmas.

Teacher #2: Judy

Judy and I first met as part of a high school mathematics summer professional development workshop in Wagon Wheel Schools. In these sessions Judy engaged with the content and was willing to share her thinking, often recalling her teaching experience to make connections between the ideas discussed in the professional development and her practice. Knowing Judy since this professional development in 2016, when I first approached her in the Fall of 2018 to ask if she wanted to be a participant in the study, she immediately accepted. At this point in time, Judy had been teaching for twenty-two years, seventeen of which are in Wagon Wheel Schools, at Mountain Range High School. Judy's course load includes Algebra II, Geometry, and Algebra II-B (the second half of a year-long Algebra II option).

Judy says in the first interview, "People would be embarrassed to say, 'I can't read,' but nobody's embarrassed to say, 'Oh I can't do math,'" something she finds unacceptable. From Judy's perspective, she sees students come to her classroom with a disposition towards mathematics that is predominately negative. With this in mind, when she is teaching mathematics, what matters most is, "getting the students not to be scared of it." Judy hopes to change student's dispositions about mathematics, from when they enter to when they exit her class at the end of a semester. Judy's goal for teaching mathematics is similar to what matters most, in that she, "wants to be able to reach every student and let them have the ability to at least to something with [mathematics] and not be afraid and quit and not do it." She wants them to see that, "Yes, I can!" However, though she will do anything for her students, she also has an expectation that there must be some buy-in from the student as well—she tells me she will "get every student that

wants it, a way to do it.” Judy’s vision and orientation towards teaching mathematics is evident throughout the sections that follow. Additionally, her experience, professional learning, and self-described research act as primary mediators for the dilemmatic situations she encounters.

Dilemmas. Four categories highlight the dilemmas Judy experiences in her practice— the dilemma of collegial collaboration, the dilemma of curriculum change, the dilemma of supporting students’ grade-level understanding of content, and the dilemma of unplanned school closures.

The dilemma of collegial collaborations. In my time with Judy, she often expressed a desire to collaborate with other teachers in her school. This desire has often been left unfulfilled for Judy as it was often difficult for her to find peers of which she could collaborate. For instance, when she initially started working at Mountain Range High School, she found the general attitude towards collaboration to be, ‘I created this, you can't use it.’ This isolated stance towards the teaching profession is not one that meshes with Judy’s personality, as she told me, “I hate that attitude and I’ve never been that kind of person.”

A difference in attitude and approach to the profession was not the only way Judy found a tension in seeking out collegial collaboration, she also found her teaching style to differ from some of her colleagues. She describes how when she first came to the high school, and still today, “many of the math teachers here... [are] stodgy.” She uses this description of other teachers being dull and uninspired, because she says many teachers teach using their textbook alone. She tells me that other teachers teach in a way that, “I mean it’s, ‘Okay, we do page one. Okay, we do page two. ... Okay, we do page five.’”

However, Judy's tells me she has, "never done that." This difference in teaching style forces Judy to further isolate herself, while still wanting to collaborate with her peers.

The dilemma of curriculum change. Judy's twenty-two years of experience have given her a confidence in her abilities to teach mathematics. However, when asked what could help her become the teacher she wants to be, she said, "Oh, that's a deep thought one. Cause in a lot of ways I'm not as good as I want to be, but I think I'm an excellent teacher." Moments later she added that it would be helpful if her standards and curriculum were not changing every few years. This flux in curriculum expectations creates a dilemmatic situation for Judy that is evident in two ways when planning for the teaching and learning of mathematics—evaluating her own existing curriculum materials and evaluating those that she finds through research.

First, Judy lacks confidence in the relevance of her own, teacher-made curriculum materials. This causes Judy to feel that she is constantly having to reinvent her teaching, rather than do the work of improving. As she mentions:

I don't feel like I've been given a chance to fine tune in years because every time I turn around, I'm being jerked a different direction. How do you become the teacher you truly want to be when every two years you're having to totally reinvent what you're teaching? You can't fine tune it. And so, if I had, my dream would be to be able to actually have the time not feel pressured and to be able to find tune what I'm teaching.

This feeling of never being able to fine tune her work, due to consistent curriculum change, creates a tension where Judy is constantly doubting her existing curriculum materials in favor of something that feels like a reinvention.

Second, Judy experiences this dilemma of curriculum change as she conducts self-described research for curriculum materials. For instance, she describes having a district approved textbook, but not having one that is adopted with the current state standards in mind. This leaves Judy wondering about the practicality and reliability of using a textbook at all. She also describes experiencing a tension with the reliability and availability of appropriate curriculum materials found on the internet. For instance, she cites being “upset” and “discouraged” at the loss of a state-wide teacher-made website that linked a variety of virtual curriculum materials with corresponding state standards. The loss of the website has caused her to look elsewhere, but, as she told me, “You know, you go in, but you have to, you have to look at stuff even though you know it's a good website, but it doesn't always fit what you want.”

The dilemma of supporting students’ understanding of grade-level content.

Throughout the study, Judy describes two ways she experiences problematic situations that relate to supporting students understanding of grade-level content—making content approachable and teaching multiple levels of students.

When describing how making content approachable is problematic, Judy talks about having a lack of confidence in students’ mathematical ability. This lack of confidence causes Judy to consider how she can provide students a stronger foundation in mathematics while also preparing them to be successful with the standards of the course. From this arises a tension where Judy has to make decisions about that create conflict between pacing and teaching for understanding. She describes thinking, “The more foundation I can give them, the more I can do.” Placing herself in a situation where she feels behind on pacing, but “because [she] gave them that background, yes, [she’s

behind], but [the students] understand it.” This lack of confidence in students’ abilities also leads Judy to provide students a more direct means of teaching. She describes it as one where:

When I'm teaching, as far as something new or teaching them the steps or different things, is I try to set it down in a very orderly fashion and give them notes on, "Okay, step one, do this, step two do this, step three do this, step four, do this," and that, that reaches that visual and, to a point, kinesthetic, because they are writing and the kinesthetic and visual cross as they're writing the different steps. And then I talk about it. I'm constantly verbalizing not only just the words I'm writing but filling in the gaps in between them.

This is also described by Judy as teaching to the three modalities—visual, kinesthetic, and auditory. An approach to teaching that she describes as being the most effective with the majority of her students.

This dilemma is furthered when Judy begins considering the different levels of students she has in her classroom. She tells me, “I don’t teach advanced classes,” and, “Your classes are so crazy, ‘cause you get the low, you got the high, got the middle.” This perspective on her students causes Judy to, “start with the low and kind of feel the waters to see how fast [she] can go with them or different things that [she] can skip with them,” creating a tension between her wanting to support struggling and advanced learners at the same time. Often finding herself leaning towards a focus on struggling students because her district and school administration are “looking at gains” across the year to show up on state assessments.

The dilemma of unplanned school closures. At the time of the second interview with teachers from Mountain Range High School, the district had not been open in the spring semester for more than three days each week. Closures due to inclement weather and sickness had set off a series of days out of school that itself brought about tensions to Judy's work as a teacher. As she describes, "Probably, well the days out, making decisions as to when are you going to do things." Judy talked about struggling with just how flexible she should be with her expectations for curriculum coverage by the end of the semester, when to conduct tests over material, and how to manage homework, often not even being sure she would see the students the next school day. This dilemma is summarized when Judy asks, while discussing the plethora of days out of school, "How do you make sure the kids know what's going on?" She has plans and puts thought into what she will be doing each day, but the uncertainty of when school would be open left her in a state of wonder about her practice and how to make it effective.

Resources. Four categories delineate how Judy conceptualizes resources for her practice: curriculum materials, technology, experiences, and collaboration.

Curriculum materials. When describing curriculum materials as a resource, Judy has three sub-categories: research, teacher-made, and district/state provided. In describing research, Judy talks about, "constantly looking for new things [on the internet]." While Judy says that she often finds herself typing in a relevant phrase to Google to see what she can find, she also talks about being skeptical of sites she visits, saying, "I just don't trust a lot of it. You know, you go in, but you have to, you have to look at stuff even through you know it's a good website." Websites that she does trust and revisits, are scribbled post-it notes at her desk that she finds "nice to have" (e.g.,

Tennessee and other state websites, and mathematics teacher blogs/websites from the likes of Dr. Jo Boaler at Stanford and Dan Meyer at Desmos).

Judy also talks about curriculum materials by way of being teacher-made. Teacher-made materials include both her collection of self-made materials from previous years and materials from other teachers in her school. She talks about pulling up old PowerPoint presentations, handouts, and activities, and talking with some teachers over time to gather materials they have found successful in their classrooms.

Finally, Judy describes curriculum materials in terms of those provided by her district. This sub-category includes things like the current textbook and previously adopted textbooks and workbooks. It also includes the state standards and information she can glean from the state website (e.g., sample assessment problems and focus standards for the course).

Technology. Technology is something Judy uses frequently in her practice. The technology she is using is teacher-centered and includes a laptop, interactive whiteboard, and various software programs (e.g., PowerPoint and Flipchart). For Judy, PowerPoint is a primary piece of technology that she uses in her practice that was consistently brought up throughout our time together. In an interview she told me:

I use a lot of PowerPoint. I use a lot of the flip charts. Um, I design them, I make them, I work hours and hours on them. My PowerPoints are not slide with words, slide with words. My PowerPoints have music, my PowerPoints have dancing, my PowerPoints have movement. They have, PowerPoint does not have to be dull and I don't make mine dull.

It is also relevant to note that Judy has used PowerPoint throughout her career, constantly learning new ways to utilize the program, furthering her technology and technological pedagogical content knowledge (Koehler & Mishra, 2009) in relation to using PowerPoint in the classroom.

Experiences. When describing experiences as a resource, Judy does so in two ways—professional learning experiences and teaching experience. For Judy, professional learning experiences include professional development and university coursework. These experiences are, “too meshed,” for Judy to discuss in the interviews, but in her resource diary she mentions using, “notes from previous professional developments,” to help her plan a Geometry lesson on area, volume, and circumference. She also frequently references her special education trainings as a resource for her practice, specifically saying, “What I figured out is that methods or ways that I teach a special ed child usually works really well with a regular kid too.” With respect to university coursework, she often recalls professors and activities that she draws on. A key part of Judy’s teaching stems from her undergraduate experiences where her mathematics education professor kept telling her, “Teach subjects, not books.”

In terms of teaching experience, Judy talks about her work with students in current and prior classrooms and tutoring through a local community college and in the community. These experiences provide her the opportunity to work with a variety of individuals and constantly learn about how students think about mathematics. These experiences also provide a more nuanced knowledge of the curriculum with respect to student thinking about mathematics. She has learned multiple ways to reach the same

content-related goal and has expanded aspects of her mathematical knowledge for teaching (Hill & Ball, 2009).

Collaboration. Collaboration with colleagues has not always been a resource that Judy can utilize; rather, it is something she has had to cultivate over her time in Wagon Wheel Schools. After finding ways to cultivate collaboration with her colleagues, she has found that collegial conversations and interactions act as a resource to inform her practice. For instance, Judy describes collaboration as a resource she “love[s]” and that “verbalize[s]” the intention of curriculum materials shared between her and her colleagues. She also talks about going down the hall or next door to ask questions about working with both students and mathematics content.

Resources as mediators of dilemmas. Judy’s conceptualized resources—curriculum materials, technology, experiences, and collaboration—each play a mediating role in the dilemmas she experiences—the dilemma of collegial collaboration, the dilemma of curriculum change, the dilemma of supporting students’ grade-level understanding of content, and the dilemma of unplanned school closures. Findings on the role of Judy’s resources as mediators of the dilemmas she experiences is explored in the following sections.

Mediating the dilemma of collegial collaborations. Judy experiences a dilemma related to collegial collaborations in that she finds it difficult to find peers in her school of which she can collaborate. She describes finding an isolated stance towards teaching and having a different teaching style as two ways she experiences tensions relate to this dilemma. To find ways of cultivating collegial collaborations, Judy had to remain open

to collaboration while waiting for others to cooperate. The following passage from an interview describes Judy's experience with this dilemma:

So, when I came over here and started teaching, uh, Barbra started seeing some of the things I was doing and she was like, "I'm just not good at PowerPoint," and, "I just couldn't do something like that." And I go, "Here, take it." And she's like, "No, no, no, that's yours." I'm like, "No, it's not. Here, use it." And what I found was after I did that a few times... what happened was she would look at my stuff and do my stuff and she goes, "You know, I really wish that you'd mentioned this or that the PowerPoint mentioned this." And I go, "Oh man, that's a great idea." And so here I am rewriting. Or she'd say, "You know, if we did it this way instead," and it's like, "Oh yeah!" And so, I'm rewriting. And so, we found before long that together... she worked with me constantly in almost as the, as the critical or the... proofreader or whatever. I did 90%, 90-95% of the work, but she was always there for me. We always worked together.

This passage shows how Judy had to remain open to collaboration and how she was able to use her teacher-made curriculum materials and use of technology to bridge collaborative situations with her colleagues. Though Barbra has since retired, Judy has found a collaborator in Christa (Teacher #3) who had a short period of working with Judy and Barbra, and subsequently assumed Barbra's position. Judy talks about how she has, "been very lucky in that when Barbra decided to retire, Christa had come in, so we, I had already kind of developed that relationship with Christa because she was a part of our [group]." This collaboration between Judy and Christa became tenuous because their

schedules became more disjoint. The two still share ideas and experiences with each other, but Judy describes her situation as on where:

Nobody else will sit down and work with [her]. There's a lot of takers in the department. "Oh yeah, you make it and I'll use it," but there's nobody that's willing to sit down and say, "Okay, let's try this," or, "Let's work on this," or "Hey, I'm having this issue too."

Thus far, this dilemma of collegial collaboration has been subject to Judy's openness and sharing of resources, but recently has been mediated by the introduction of PLCs within the mathematics department. Judy says that PLCs may not work how they are intended to, but she does believe that PLC is opening the door to collaboration that wasn't there before.

Finally, Judy describes curriculum materials she finds through her research on the internet as a mediator of this dilemma. When she wants to gain new perspectives and ideas to improve her practice, and her colleagues are not providing that collegial collaboration to do so, Judy finds that state websites, blogs, and mathematics teaching and learning related websites, like YouCubed and various Three-Act-Math and state- and district-created websites, have provided a means for her to continue learning from others and improve her classroom instruction.

Mediating the dilemma of curriculum change. Judy is very conscious of changes to her course curriculum at the state-level. The constant flux in curriculum expectations has placed Judy in a situation where there exists a tension between state expectations and the curriculum materials she has at her disposal. First, she lacks confidence in the relevance of her own existing curriculum materials for use in today's

classroom. Second, Judy experiences this dilemma as she is conducting research for curriculum materials she can supplement for her classes.

Judy mediates these experiences within this dilemma in much the same way. The primary mediator is her experiences, both professional and teaching. Judy's experiences inform her decision making about the use and relevance of both her teacher made materials and those she finds through research. For instance, as she interprets various curriculum expectations and standards, Judy often looks for "good explanations" of content. When asked how she knows what she is looking at is a good explanation, she says, "That's just experience, that's just experience, and that's all I can say. That's just experience." When pushed further on this topic, Judy describes viewing a dynamic between the language different materials are using with respect to how her students are going to understand the language. She drew on her experiences and knowledge of working with students to evaluate both her own teacher-made and research-found curriculum materials. For Judy, she says that these experiences informed how she was able to evaluate if materials are using a "common language" that can lead to the "proper wording" to support students' understanding and access to the content.

Other resources Judy draws on to mediate this dilemma are old textbooks, the internet, and collaborations with colleagues. With a textbook that was not adopted at the time of the curriculum changes by the state, Judy is left using a primary resource for any teacher as more of an outside "guideline" and "tool." Without a textbook that is designed to guide her teaching, Judy relies on a bricolage of curriculum materials and experiences to design her own. She describes this process through the following quote from an interview:

One of my biggest issues is that I very, very, very, very rarely use something that's pre-made [from other teachers or the internet]. Because it's not the way I teach, it's not the emphasis I put on it, it's not the way I explain it. I get ideas from other things sometimes. Um, I've got a quirky brain and, and it works creatively, um, that's just the way I am.

Though she does seek out other materials from other teachers and the internet to bridge with what she has already created, she does so in her own way, adapting materials based on her experience.

Mediating the dilemma of supporting students' grade-level mastery of content.

Judy constantly feels a tension when attempting to support students' grade-level mastery of the content she is required to teach. This tension exists due to the realities of state testing, state standards, and school accountability and are experienced in terms of how she decides to make content approachable and in how she is able to teach multiple levels of students. In response to this dilemma, Judy's actions and decisions are mediated by her experiences and collaboration.

First, Judy finds that her professional learning and teaching experiences, particularly her special education trainings, mediate the tensions that arise out of this dilemma. For instance, Judy has a lack of confidence in students' abilities to approach the content as is, feeling the need to go step-by-step and break things down for the students. To do this, Judy falls back on her special education trainings that help her structure lessons and figure out ways to explain things so that it is approachable to the student. This approach helps her not, "talk over their heads." Her use of professional learning and teaching experiences are best articulated by Judy in the following passage:

What I figured I out is that methods or ways that I teach a special ed child usually works really well with a regular kid too. And it's, it's amazing. Um, and the students comment on the way that I explain things, the way I break things down, that I make it where they can understand it.

This is an example of how Judy is using her experiences as a mediator for how she is approaching the classroom today, in context.

Through her collaboration with others, Judy also is able to mediate this dilemma, as she is able to come to terms with her decisions by running them by her peers. Though she has only a few peers of which she can collaborate with, she does use these peers to support her decision making and to make sure she is presenting material in an approachable way for the students. Her experiences working with Barbra are an example of where she was able to use collaboration to make adjustments to her materials so that she can better support student understanding. And even though Judy is able to use her experiences and collaborations with colleagues to mediate this tension, she told me that she has nothing else to use or draw on that would help support student foundational understanding while continuing on with the curriculum. She was asked, “Do you find resources [at the school or online] that help you [move forward with the curriculum while also rebuilding students’ prior knowledge]?” She replied, “No.”

While Judy is able to mediate this dilemma in terms of making content approachable with her experiences and colleagues, she still experiences a tension when supporting the learning of different levels of student understanding. This is a tension that is not well mediated by resources available to Judy, and she finds herself not always able to support a more advanced student in a classroom where she doesn’t believe the majority

are advanced. She describes, “starting with the low,” and, “feeling the waters,” to see what she can do with the students. Another interpretation is that Judy is relying on intuition and improvisation, mediated by her experiences, to work with different levels of student’s moment-to-moment in her classroom.

Mediating the dilemma of unplanned school closures. Unplanned school closures created a variety of challenges for Judy. Of note is that a tension was created with just how flexible she should be with her expectations for curriculum coverage by the end of the semester, when to conduct test over material, and how to manage homework. At this point, Judy wants to teach for understanding but feels that she needs to push and provide more direct instruction that may lack the depth; she wants to get an assessment over a set of content standards but doesn’t feel that the students are going to remember and be successful on the assessment; and she wants to have students do work on days off but finds that they do not do homework on days when school is closed. As she puts it, “How do you make sure the kids know what’s going on?” In talking about this dilemma of unplanned school closures, Judy does not believe she has anything to help her manage the tensions it creates. “I don’t, I don’t,” she says, but she does rely on her experiences and collaboration with colleagues to help her make critical decisions. In addition, Judy is aware that some teachers are using the Remind app to communicate with students on days off, but told me, “That is something that I would have liked to have gotten set up. That was one of my goals, was to try to get that, but this year has just been so crazy for me.” Her district is also one that does not have an online education platform (e.g., Canvas or Blackboard) to communicate information to students. Rather, Judy is relying on being face-to-face to communicate with students, a situation not available when

school is closed. Thus, this dilemma remains unsolved, but is mediated by her teaching experience and collaborations with peers to come to terms with her actions and decision making.

Summary. Judy's conceptualizations of resources and description of dilemmatic situations illustrate a teacher who uses her experiences, technology, collaboration, and curriculum materials that are teacher made, found through research, or provided by her district, to mediate the dilemmas she experiences. In particular, collaboration and Judy's teaching and professional learning experiences are primary resources she makes use of to do the work of teaching and learning mathematics. Figure 3 summarizes the mediating relationships resources have with the dilemmas Judy experiences and the decisions she makes in-context-in-practice that were laid out in her individual description.

Teacher #3: Christa

I first met Christa at the end of her second year of teaching, when she participated in a week-long high school mathematics professional development workshop in Wagon Wheel Schools. At the time of the study, Christa was in her third year of teaching and the middle of her second school-year teaching at Mountain Range High School. Currently, she is teaching a variety of sections of Algebra II and the previous year had taught different levels of Geometry. This shift, she says, is because her school is, "in the transition of [having students take] Algebra II before Geometry, so we had a lot of kids take an Algebra II [this year]." With her limited experiences in the classroom, Christa has already found a preference for Geometry. She has this preference because she believes that students are better able to understand the content and it is easier to use hands-on manipulatives. In comparing the two, she describes how in Geometry she, "I

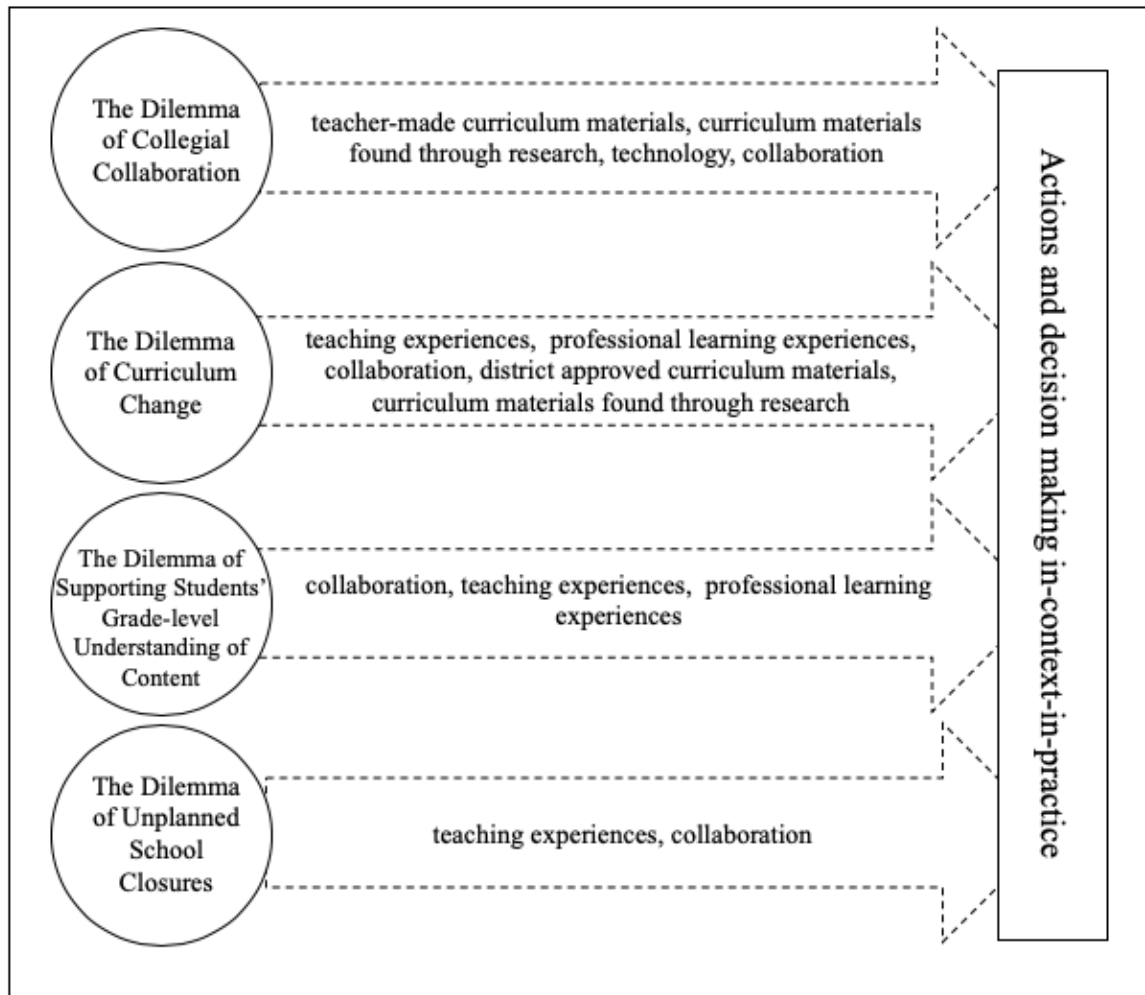


Figure 3. Overview of Judy's resources mediating dilemmas.

can show [the students a sphere] and they can pass it around, they can see it, feel it, touch it. And with Algebra, I feel like it's a little abstract sometimes. They can't see it."

Though she may have an early preference on what she enjoys teaching, overall Christa wants students to understand how and why mathematics makes sense. She says, "I'm a big stickler on telling them why it works. I don't like teaching them shortcuts or tips or tricks." She doesn't mind these strategies arising organically in her classroom, but she wants students to know that, "if you can't remember the rule or the tip or the trick, you can always go back and do it the long way." Additionally, Christa relies on classroom discourse and student participation as important features to how she is able to run a class and support students' sense making about mathematics. In all, Christa's data provided insight to her thoughts about teaching and learning mathematics, expanding on this idea of helping students make sense of mathematics, and lays the foundation for the following sections that illustrate how she describes dilemmatic situations, conceptualizes resources, and how the resources she describes act as mediators for the dilemmas she experiences.

Dilemmas. The dilemmas Christa experiences in her practice are described by two categories—the dilemma of using technology and the dilemma of ambitious teaching.

The dilemma of using technology. Christa has a desire to use technology in her classroom to motivate her students and to aid in her planning and classroom instruction. However, in practice she experiences dilemmas related to using technology in two ways—accessibility and reliability.

In describing the use of technology, Christa talks about tensions that highlight the accessibility of technology. At her school there is a laptop cart that teachers can request from the library. However, Christa says that it is not always available and with classes that are as large as 35, a laptop cart of 32 is insufficient. This requires Christa think about using the laptops days in advance—something that may not play out based on how she adaptively paces and plans units and lessons—and to consider what to do with three students who will not have access to a laptop. Additionally, Christa may want to have students use an online platform (e.g., Google Classroom), but there is a tension in asking students to do that because, as she says, “Just so many of my kids don’t have personal devices, don’t have internet at home, I don’t feel like I can do that.” This dimension of accessibility creates a tension that Christa must deal with if she is planning to incorporate technology in her classroom.

Another dimension that this dilemma is experienced through is reliability. This is exemplified when Christa describes using the Remind App to remind students to bring a device if they have one and then trying to have all students online at once in her classroom. She tells me, “Having thirty people connected to the internet at the same time proved to be a problem,” and that she can’t always rely on students to check the Remind App before class. In addition, there is a lack of reliability in the technology provided by the school, as the laptops on the laptop cart may not all be in service at the time of use.

These instances are examples of tensions that Christa must deal with if she is planning to use technology in her classroom.

The dilemma of ambitious teaching. The following quote encapsulates Christa’s experience with the dilemma of ambitious teaching:

I don't want to feel like I'm undershooting for the kids. I don't want to not give them that because I feel like they can't do it. I just want, whenever they do problems like [those in our textbook], I want them to have the knowledge they are supposed to have. I don't want to just throw them in there.

This is a recurring experience for Christa where she finds herself wanting to do activities or give challenging open-ended problems, but is left wondering, "How do I get from point A to point B? How can I get them to this part?" She is wondering this because she feels a tension between what she expects the students to know and understand with prior knowledge and what the students actually are coming to her class knowing.

Being a third-year teacher, Christa also feels like she needs to design her own curriculum for her students. She lacks confidence in her textbook telling me that, "There's some stuff I don't agree with," and finds herself having one "crazy" day trying to map out a semester long plan that utilizes and improves on what she has done previously.

Another way Christa experienced this dilemma of ambitious teaching is through tensions that were brought about from unplanned school closures. Christa talks about similar tensions and experiences to Judy, but describes it as finding, "Anything to make [my teaching the standards] kind of go a little faster." She feels a tension between having days off and not having a state assessment date that is flexible, forcing her in a problematic situation where she must make critical decisions about her classroom instruction.

Resources. Five categories highlight how Christa conceptualizes resources for the teaching and learning of mathematics: students, formative assessment, other teachers, school materials, and data, standards, and past experiences.

Students. When Christa talks about students as a resource, she does so in two ways—her understanding of the student experience and the classroom community. Overall, Christa believes her students are a resource “because whenever [she’s] planning, [she’s] trying to think about what’s best, what’s best [for her students].” In using understanding of the students, Christa is talking about her knowledge of their dispositions and past experiences in mathematics classrooms. She uses an information sheet that students record responses to a series of questions from the beginning of the semester. Here, students tell Christa information about their preferences in class (e.g., where do they like to sit and if they enjoy working in groups) and experiences as a mathematics student (e.g., what makes them enjoy math class, what do they hope the teacher is doing). This understanding of her students is also brought about through the relationships she builds with each individual. Christa tells me that she, “feeds off of other people’s emotions,” and having relationships with students is important so that when they enter her classroom there is a positive feel that she can utilize. This leads to how Christa describes students through the classroom community. In this sense, she talks about how cultivating community helps students feel more comfortable in her classroom and aids in their willingness to participate in class discussions and ask questions. She also talks about classroom community when she is talking about groupwork and how students are willing to share their thinking so that the class can discuss similarities and differences.

Here, the classroom community is a resource to support the teaching and learning of mathematics in her classroom.

Formative assessment. Christa talks about formative assessment as a resource when she discusses planning for and teaching mathematics. A primary example of formative assessment that she describes is a pre-test that she has students complete at the beginning of the semester. She goes on to describe using individual whiteboards for practice, 1-2-3 fingers in the air to show understanding, and exit tickets as in-class formative assessments. Christa also says that she tries to, “talk as little as possible,” because another way she thinks about formative assessment is through questioning and uncovering student thinking.

Other teachers. In describing other teachers as a resource, Christa does so in two ways. The first is through her colleagues in the school. For example, Christa talks about being, “the new guy... so if I have questions, they’re like, ‘Oh yeah, I ran into that.’” Specifically, she talks about working with Judy (Teacher #2). She describes Judy as a knowledgeable other who she can rely on telling her what she would do while also listening for potential challenges and pitfalls.

The other way that Christa talks about other teachers as a resource is by accessing a teachers’ thinking and experiences through internet-based blogs and teacher-made materials. For instance, Christa describes frequently visiting and reading the blog *Math Equals Love*, run by Ms. Sarah Carter, as a primary resource. She also visits sites like *Math Giraffe*, *Teachers Pay Teachers*, and *state websites* to see what other teachers are doing in their classrooms and find ideas for hands-on activities and creative ways to provide notes.

School materials. Christa talks about many materials she uses at her school as a resource. In describing these materials there are two sub-categories: technology school materials and non-technology school materials. With respect to technology, Christa brings up things like her interactive white board, calculators, online quiz platforms (e.g., Kahoot, Plickers), and computer software (e.g., Desmos, Flipchart, Kuta). It is also observed that she has a document camera and a classroom set of TI-Nspire calculators. With respect to non-technology school materials, Christa describes using mathematics manipulatives (e.g., dice, Algebra tiles), individual whiteboards and markers, and notebooks. I also observed that she has tubs that contain glue, scissors, dry erase markers, and pieces of cloth, that sit atop groups of four to five student desks around the room.

Data, standards, and past experiences. This final category seems like a hodgepodge of resources but is actually brought together by Christa on her Map of Resources. In talking about this category, Christa is talking about student data (e.g., state assessment data and classroom-based data), state curriculum standards, and her past experiences teaching and working with the curriculum. Of note here is her description of past experiences. She tells me she is thinking about, “What worked, what didn't work,” and feeling like she is now able to, “kind of look back at what I had already done and build off of it.” However, each are resources that she considers and draws upon in her practice.

Resources as mediators of dilemmas. Christa's conceptualized resources—students, formative assessment, other teachers, school materials, and data, standards and past experience—each play a mediating role in the dilemmas she experiences—the

dilemma of using technology and the dilemma of ambitious teaching. Findings on the role of Christa's resources as mediators of the dilemmas she experiences is explored in the following sections.

Mediating the dilemma of using technology. It is not apparent that Christa has many resources to mediate the dilemma of using technology that are readily available nor reliable. She has access to a laptop cart, but that access is limited to availability and sharing with others in her school. She has access to the internet, but speed and reliability often becomes an issue with high usage in her classroom. She also has access to online classroom platforms, like Google Classroom, but not all of her students have internet-ready devices available to them to access the platform at home. With this in mind, Christa does still see value in using technology in her classroom and attempts to use it as much as possible. However, she is aware of resources that would help her mediate this dilemma of using technology when unavailable or unreliable. For instance, Christa is aware that personally she could apply for, "grants and stuff," to help work through these tensions and buy technology for her classroom. She also told me about an article she read that described a community that faced similar issues of internet connectivity for students at home. She remembers that this district:

Figured it out. ...each student had their own personal device... and with the internet, they actually put like, I don't know if it'd be routers, but they put it on top of their school busses so [the students] had internet on the school bus... but they also would park their busses in specific places around the county, that way [the internet] would reach more students.

Christa believes that if Wagon Wheel Schools would consider something like this, that it would help her sort through many of the tensions and problematic situations she experiences with using technology. However, she also admits, “I mean that might be a little farfetched, but that’s one way I’ve heard about solving the problem.”

A benefit Christa sees that stems from using technology is that it raises student interest in what they are doing, and if she is not confident in the availability and reliability of technology to use with her students, she considers non-technology-based alternatives. Thus, Christa also makes use of math manipulatives, school materials, and tries to find hands-on activities from other teachers, both in her school and on the internet, that will keep students a little more interested in what they are doing while also mediating her experience with this dilemma of technology.

Mediating the dilemma of ambitious teaching. The dilemma of ambitious teaching is not an easily mediated dilemma for Christa. She wants her students to experience high-quality instruction, but often cites inexperience as a hurdle that she has to overcome. In doing so, Christa makes use of every resource at her disposal to support her actions and decision making in response to problematic situations that stem from this dilemma.

First, Christa experiences the dilemma of ambitious teaching when she is planning and thinking about how she can get students, “from point A to point B.” She describes how her lack of experience teaching has led to a tension between what she expects the students to know and what they are coming to her class knowing. This dilemma is often mediated in-the-moment, as she is teaching. She uses formative assessment, classroom community, and her understanding of students to gauge student understanding as she is

teaching. She does this by asking questions, encouraging discourse, and slowly developing and uncovering student thinking about the material in a progressive way that promotes moments of success. The following passage is an excerpt from an interview when Christa described a classroom experience and in-the-moment decisions that led to the mediation of this dilemma of ambitious teaching:

We just got done talking about slope. Talking about, you know, when you say slow. They're like, "Oh no." They remember that, they talked about it for so long, and so we talked about slope. Um, I'm really kind of nervous about graphing with them. They just, any big jump from one thing to another if they struggle with, it's like, "Okay, so we still need a little bit of practice on finding slope, but I don't want to spend another day just finding slope. So, we will find slopes, but now we'll have to decide are they parallel, perpendicular or neither? So, we're adding one, a little extra step to it. Now I'm going to give you not the two points. I want to give you the equation. So, manipulate the equations, figure out the slopes, are they parallel perpendicular." And then we'll just, now that they have practice manipulating the equations, they are used to putting it in like slope-intercept form. Now we can graph it, because they're comfortable with everything up to that point. So, I try to build them up little by little. Um, because they'll say like, "We're nervous about graphing." So, I try to do that, I try to think of little, and it may not even be stuff, they'll like, I have to show them, but if it'll kind of bridge the gap if it's like a baby step up.

Christa also experiences this dilemma of ambitious teaching by not having confidence in the curriculum materials she has at her disposal. For instance, when talking

about the textbook, she tells me that, “There’s some stuff I don’t agree with,” and without having access to an approved pacing guide, she finds herself having one “crazy” day trying to map out a semester long plan to improve on what she had done previously. This problematic situation is mediated by other teachers, school materials, and data, standards, and past experiences. In particular she uses a class pre-test, student data from the most recent state assessment, the textbook, and her recollection and materials from her past experiences teaching to help her make decisions about how to go about teaching a new set of students class to the best of her ability and in an ambitious, high-expectation fashion. She also uses her understanding of students to think early on about preferences in learning style for each class, of which she intends to accommodate. This is best described by Christa in the following interview excerpt:

I had one like crazy day where I just sat down, I put, I went through the standards and the raw scores from the year before and I said, "Okay, this standard was taught, was hit really heavy on the test, so I know I need to cover this. And then this standard was what they struggled with the most. So, whatever I'm doing isn't good with that... Here's all the stuff they need to know to do, and then this is a list of stuff that they need to know but I don't think that they know."

The final way Christa experienced this dilemma was with regard to the problematic situations that were a product of unplanned school closures. In talking about this situation, Christa tells me:

As bad as I hate it, I kind of cut out the activities, or we shorten them, and that's bad because I feel like I'm cutting out the best part of it and maybe the part that they get the most out of. But it's kind of like, I just need to give you the material.

... But I've also, you know, normally I'm like, okay, we'll talk about it for a little while, we'll do an activity, they'll do some work, then we'll talk about their work—and that's kind of how most of my lessons go. But now it's, we're going to talk about it for a little while, they're going to do some work, we'll talk about it if we have time, if they have questions, we'll do some more. And then we go on. So, like this past week we were really here for two days, but we didn't do an activity any of those two days and last week we were here for three days and I think we only did an activity for one day. So, um, if we do have an activity, I try to make it shorter, I may cut it in half, so they have less problems to do. Stuff like that. Anything to make it kind of go a little faster.

This passage from Christa's interviews shows the tensions she deals with while wanting to teach in a way that is ambitious, a way that, "they get the most out of," but often finding herself sacrificing the ambitious teaching to, "just give [the students] the material." This is not a simple decision for Christa, but what mediates this dilemma is her understanding of students, classroom community, and formative assessment. She describes that:

While we've been out a lot, we've been here a little bit where I know my students decently well. So, um, I can kind of gauge if I think that they'll be fine, or I always still have the activity ready just in case. But you know, I do the thing where I have them hold up three fingers. If they all hold up three fingers, I think they've got It, we're not really going to do the activity. But there've been days where they were like a one or a two, so they weren't really sure about it. So, we went ahead and did it, but if they're doing pretty good, if they're answering

questions well, if we do whiteboard problems and they get them all right, then we just go, we go on.

Summary. Christa's conceptualization of resources and description of dilemmatic situations illustrate a teacher who uses her students, formative assessment, other teachers, school materials, and data, standards, and past experiences as primary resources to mediate the dilemmas she experiences. It is also apparent that her awareness of having a lack of practical experience is balanced by her desire to learn from both other teachers in her school and those that post blogs and curriculum materials on the internet.

Figure 4 summarizes the mediating relationships resources have with the dilemmas Christa experiences and the decisions she makes in-context-in-practice that were laid out in her individual description.

Teacher #4: Kate

I first met Kate at the same professional development that I met Christa, a week-long high school mathematics professional development workshop in Wagon Wheel Schools. At the time of the study, Kate was in the middle of her fourth-year teaching; the third, of which, was taking place at Mountain Range High School, in Wagon Wheel Schools. Her course load is uniquely different than that of the other four teachers who participated in this study. Kate teaches Geometry and Biology intervention classes for students with learning disabilities, each for half of the day. As an undergraduate, Kate majored in special education, and later she earned her state credentials in secondary mathematics, after her initial licensure process.

While teaching both mathematics and science classes, our conversations focused on the teaching and learning of mathematics. In our discussions and based on my

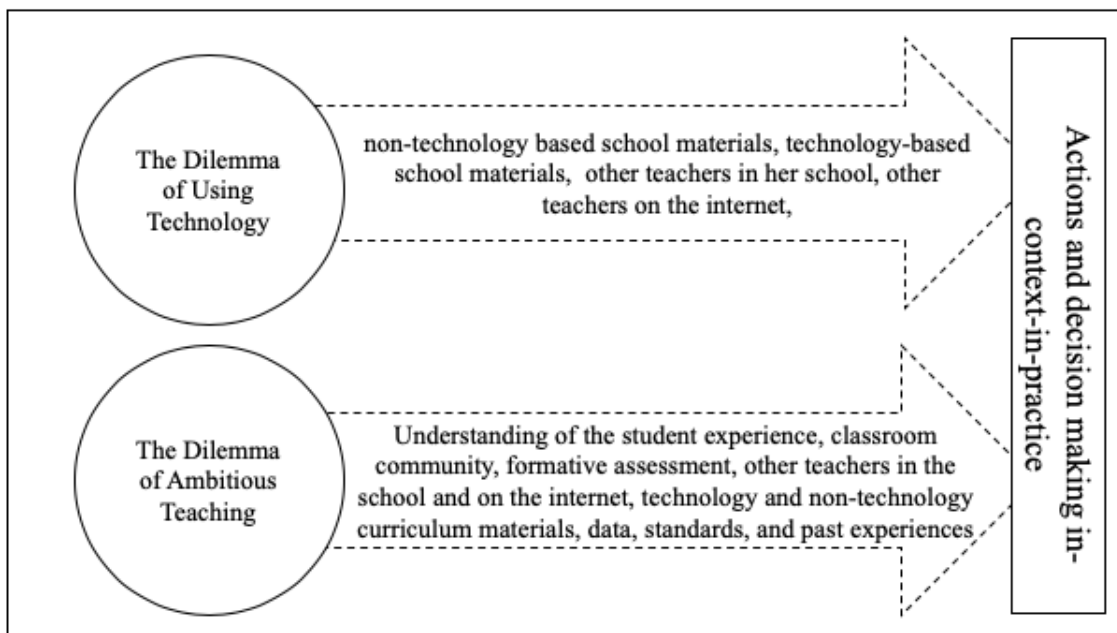


Figure 4. Overview of Christa's resources mediating dilemmas.

observation, Kate's main focus as an intervention mathematics teacher is to help support students' thinking and problem-solving skills. She describes, "Try[ing] to get them thinking about things outside the box a little bit," and how she differentiates and provides structure for students to build their mathematics skills. Kate cares for her students and wants them to feel successful as mathematics learners. Kate's data provided insight to her thoughts about teaching and learning mathematics, expanding on this idea of supporting student thinking and success in mathematics. Her data lays the foundation for the following sections that illustrate how she describes dilemmatic situations, conceptualizes resources, and how the resources she describes act as mediators for the dilemmas she experiences.

Dilemmas. The dilemmas Kate experiences in practice can be described in three categories: the dilemma of understanding unfamiliar content, the dilemma of curriculum materials, and the dilemma of presenting content.

The dilemma of understanding unfamiliar content. Kate is not a trained mathematics teacher; rather, she is a trained special education teacher who later became certified to teach mathematics by passing Praxis exam requirements in [the state]. This alternative background to becoming a mathematics teacher puts Kate in problematic situations where she, “hasn’t seen [the mathematics] in a while,” but yet she is expected to teach this content to students. For instance, Kate recalls when she first started teaching mathematics that she struggled with systems of equations and she tells me that, “I mean, I can get through Algebra and Geometry, which is really what I deal with anyway, once we get to Algebra II I’m probably going to need some help.”

The dilemma of curriculum materials. In terms of experiencing the dilemma of curriculum materials, Kate describes her experiences with the mathematics intervention program purchased by the district:

Our intervention stuff [on the shelves in the back of the room], the kids don't like it and it's like pulling teeth and they're not learning much. So, I kind of abandoned it and just kind of tried to map my own curriculum.

Deciding that she needs to map her own curriculum is not a decision she makes lightly, but rather is one that she views as an important step to supporting student thinking and learning in her classroom. In speaking more about her the intervention program, Kate tells me that:

There's not lot a lot of activation of prior knowledge, it's very repetitive, there's a lot of choral response and the kids do not like it. To an extent, I think it's a little bit below their level. They're not challenged.

This tension between the purchased curriculum and what Kate chooses to do is also exacerbated by the lack of laptops and/or tablets for her students. As she tells me, “One of the things we keep running into is a lot of [the purchased intervention program is] on the computer and we don’t have unlimited access to that.”

The Dilemma of Presenting Content. Working with students in a mathematics intervention course, Kate describes the dilemma of presenting content in two ways—motivating students and supporting a variety of students’ understanding of mathematics content. First, Kate experiences this dilemma in terms of presenting content in a way that motivates her students to learn. Kate describes this aspect of the dilemma when she tells me about a lesson that did not go as planned:

I just had it all planned out to tee, and on that day more than half the students were absent and ones that were here, three of them laid their head down and refused to do it. So, student motivation is something I still need to work on.

Continuing on this thought, Kate tells me that she tries to motivate the students to learn through her instructional decision making and classroom management, but:

One of the kids had autism and he's not going to respond in the same way the others are gonna respond, and the girl with emotional behavior, you know, well she's not gonna respond to me putting my foot down. You know, you have to approach that differently if you don't want a meltdown. So, at some point you can, "Well you're just going to take a zero for today." Because I mean, if they're not

going to do it, there's nothing I'm going to do to force them. I mean I can try to motivate them all I want to, but at some point, they're just not going to do it. This places Kate in a situation where she plans instructional decisions and actions with the goal of motivating students, but the realities of the classroom are not what she planned.

Kate also experiences this dilemma through the lens of supporting student understanding of content. As she is planning and thinking through curriculum materials, Kate experiences a problematic situation where she is asking herself how things would apply to her class so that the students would, “enjoy and understand,” the material. This is furthered when Kate describes tensions that arise when adapting materials she uses with her students—making considerations for time allotment, thinking that she may need to, “at least lead them through [the content] a little bit more,” and also make the content challenging and presented in a way that utilizes groupwork. As Kate says, “We do a lot of, I don't do a whole lot of note taking, but a lot of it is, yeah, practice, practice, practice and hoping that when they see enough of it that they'll get used to thinking that way.”

Resources. Four categories describe how Kate conceptualizes resources for the teaching and learning of mathematics: collaboration with other teachers, research and planning, appropriate materials, and students.

Collaboration with other teachers. For Kate, teaching at the intervention level requires her to collaborate with other teachers because, she says, “That’s what I’m here for.” One way that Kate describes collaboration is by way of something she seeks out to make sure that she is supporting and aligning with what and how the primary mathematics teacher is teaching. This means learning how the content is being taught

and understanding the learning progressions in the general classroom. A second way Kate talks about collaboration with other teachers is as a resource to help her when she has issues with content or pedagogy. As she tells me, “I’m a big talker, I talk it out with other teachers. I’m not afraid to go ask for help.” This help can come in the form of face-to-face interactions or even a phone call to a colleague after work hours.

Research and planning. When describing research and planning as a resource, Kate is talking about how she spends, “a lot of hours on Google finding ways to teach these things to different types of learners,” and asking herself, “What can I do to make this easier for the kids?” She also talks about research and planning as a resource because is not something of which she is required to do outside of normal workhours. “I research because I make a decision to research and try harder [for my students],” she says. “So, it’s all about how much I often put into it.” Viewing the action of research and planning as a resource leads her to talk about a sub-category of resources within this construct—the internet.

Kate talks about using the internet to find strategies, lessons, and individual materials (e.g., worksheets and activities) she can adapt and use with her students as she is researching and planning for instruction. In interviews and her resource diaries, Kate describes how he might use Google, but often revisits websites to inform her research and planning. These websites include the Mathematics Assessment Project, Figure This!, Three-Act-Math sites (e.g., Dan Meyer and Andrew Stadel), and blogs like Math Equals Love, by Sarah Carter. Additionally, in thinking about her research and planning as a resource, Kate talks about how she visits YouTube and Purple Math to find videos and lesson materials related to mathematics content she is teaching.

A final way Kate describes research and planning is through professional learning opportunities. These opportunities include online mathematics courses and professional developments of which she takes advantage and participates.

Appropriate materials. Kate describes appropriate materials in two ways—technology and non-technology materials. Technology materials include an interactive whiteboard, laptop computer, and access to a mobile laptop cart for students. Non-technology materials include poster board, markers, glue, individual whiteboards, candy, and mathematics manipulatives (e.g., algebra tiles). For Kate, having appropriate materials are a resource that helps her, “model and demonstrate,” mathematical ideas and support groupwork and collaboration in the classroom, but often appear through, “different things for different lessons.”

Students. Students are described by Kate as a resource in two ways—her understanding of student thinking and motivation. In terms of student thinking, Kate is referring to student participation in classroom discourse and viewing student work samples. She says that she is using student responses and contributions to the class discussions as a resource to inform her decision making, and also using student work samples to see how students are understanding the content being discussed.

When talking about student motivation as a resource Kate describes looking at students’ body language and faces as resources and has found that student motivation is a resource, she can draw on to achieve instructional goals. She also talks about getting to know students on a more personal level and finding out their interests so that she can incorporate relevant topics within her classroom instruction.

Resources as mediators of dilemmas. Kate’s conceptualized resources—collaboration with other teachers, research and planning, appropriate materials, and students—each play a mediating role in the dilemmas she experiences—the dilemma of understanding unfamiliar content, the dilemma of curriculum materials, and the dilemma of presenting content. Findings on the role of Kate’s resources as mediators of the dilemmas she experiences is explored in the following sections.

Mediating the dilemma of understanding unfamiliar content. As mentioned previously, Kate is not a trained mathematics teacher, but is a trained special education teacher. This creates problematic situations where Kate finds herself unfamiliar with content she is expected to teach. While this is a challenging situation for Kate, she does utilize research and planning and collaboration with other teachers as mediating resources to manage this dilemmatic situation. The following excerpts from Kate’s data show how she uses research and planning and collaboration with other teachers as mediators for this dilemma of understanding unfamiliar content.

An instance of this is when Kate recalls preparing for the mathematics Praxis exam for her initial mathematics teacher certification. In this situation, Kate wants to be a mathematics teacher but feels unfamiliar with the mathematics material. In response, she completes internet-based high school mathematics courses and reached out to her colleagues to mediate this problematic situation. She explains, “

I logged on and did an online course as a high school student. I took Algebra I and Geometry and Algebra II... and that gave me enough basic knowledge. I practiced it, you know, and I struggled with it at first. But I kept practicing it, and I had some of the, at the time I was in another state, and I had some of the middle

school teachers help me until I could do it. And I just kept doing it until I [couldn't].

Another way that Kate describes these resources as a mediator for this dilemma is when she describes getting stuck with “some of the higher levels of geometry” and not knowing exactly what to do:

You know, to be honest, I just look it up [on the internet] and teach myself if I don't know. Or, if I'm still struggling, I'm not embarrassed to go say, "Help me with this." And I'll go to John or Judy, and I say, "How would you say they were supposed to do this?" And, you know, I learn it so that I can teach the kids.

She also adds that she would, “get on the phone and call up John and say, ‘I can't remember the formula for this, can you help me with this, can you explain it real quick?’”

She says that he would help her understand the content and then “[she'd] explain it to the kids and it'd be okay.” These two excerpts are instances of when Kate relied on her colleagues for support, but as she describes in the first excerpt, “I look it up and teach myself if I don't know.” This shows how the two resources mediate, but also how Kate looks to research and planning prior to reaching out to her colleagues.

This point is reiterated when Kate describes how she uses her research and planning to find internet resources that can support her initial understanding of unfamiliar mathematics content. She says, “As long as I can watch a video and refresh my memory, I'm pretty okay with it.” Later in the interview she also describes how she uses websites, like Purple Math, to mediate this dilemma:

Purple Math, some of these websites like that and just look and watch how it's done. Even sometimes looking at the lesson plans or notes or something, I can figure it out and see, "Oh, this is what they want."

Using the internet for her research and planning provides a mediator for this dilemma that helps her feel confident in her understanding of the content so that she can effectively teach her students.

Mediating the dilemma of curriculum materials. The district Kate works in has provided her with a mathematics intervention program for her to use in class. However, her experiences with this program have not been positive putting her in a dilemmatic situation where she finds herself not using the intervention program in favor of mapping out her own curriculum. This decision is mediated by each of the resources that make up her conceptualization of resources—students, research and planning, appropriate materials, and collaboration with colleagues.

Students are a resource that helps her mediate this dilemma because she is thinking about student motivation. When describing the intervention program, Kate says:

There's not lot a lot of activation of prior knowledge, it's very repetitive, there's a lot of choral response and the kids do not like it. To an extent, I think it's a little bit below their level. They're not challenged... The kids just don't like it, they truly do like it. They consider it beneath them a little bit. I think they're a little bit insulted at the level that it's on.

Here, Kate is using students' motivation as a resource to help her determine if she should continue using the intervention program. Thus, the decision not to continue, and chart her own path, is mediated by her students.

Technology use and availability is another tension that is experienced within this dilemma. The intervention program has a computer-based part to it, but when thinking about using this aspect with her students she says:

One of the things that we keep running into is a lot of it's on the computer and you know, we don't have unlimited access to that. I don't have any computers in here, and special education shares a mobile cart and I don't have access to that as much as it would be needed for a lot of these intervention programs to be successful.

And when we look at programs, I have to keep asking, "Well where are we going to do the technology component?" Because it's not here, I don't have that. So that's one of the major issues that I'm looking at right now.

Being asked to use a program where the technology component is a critical piece creates a tension for Kate where even if she wanted to use the program she cannot effectively implement it because of her lack of access to technology for her students. However, in this situation, Kate does describe how she is able to sometimes use parts of the program through her interactive whiteboard and the accompanying workbooks so that the students can complete parts of the program as a class.

These situations prove problematic and Kate finds herself mapping her own curriculum. She is comfortable with this decision because it is being mediated by her research and planning and collaboration with colleagues. She describes how research and planning, in conjunction with a knowledge about what motivates her students, allows her to find relevant materials on the internet that she can use in her curriculum mapping. She uses websites like the Math Assessment Project, Estimation 180, NCTM's Figure This!, and a variety of Three-Act-Math websites to mediate this decision and finds confidence

in using these on a routine basis. She also seeks out collaboration with the primary instructor for the mathematics class the students are enrolled in to mediate this dilemma of curriculum materials. She tells me that this is a collaboration that she has to seek out, but that is useful in helping her align instructional strategies between the two classes. Together her collaborations with this teacher and her research and planning help to mediate the tensions that stem from the dilemma of curriculum materials.

Mediating the dilemma of presenting content. Kate wants to motivate all students to learn mathematics and find ways for each individual to be successful in her class. However, when working towards this ideal Kate experiences the dilemma of presenting that relates to motivating students and supporting a variety of students understanding of the mathematics content. Though often finding this dilemma unresolved, Kate does make use of appropriate materials, research and planning, colleagues, and students to mediate her dilemmatic experience.

Kate views motivation as both a resource that she can use in class and as a dilemma when presenting content. This is exemplified as Kate first describes motivation as something intrinsic to the student that acts as a resource that “can go a long way” in helping her be an effective teacher. When asked about motivation later she describes it as something she, “struggles with,” and as something she is, “constantly battling.” This experience is exemplified when Kate talks about a lesson that did not go as planned:

So, I had a great lesson planned out. I used the Estimation 180, I had this a group activity that they were going to do, we made posters, and they were supposed to match the word problem to the actual equation, numerically. I just had it all planned out to tee, and on that day more than half the students were absent and

ones that were here, three of them laid their head down and refused to do it. So, student motivation is something I still need to work on. I had them all through the Estimation 180, and then I have one with autism, and he just does what he wants when he wants, and I have one girl with intellectual disabilities, and she does what she wants when she wants. They just decided that they weren't going to do anything that day.

She goes on to describe how she attempted to prompt and encourage students throughout the lesson but found little success with a minority of the students. Though often being unresolved in practice, Kate does mediate this dilemma with appropriate materials and research and planning. She describes finding appropriate materials, such as hands-on manipulatives, that will engage students and motivate them to keep working during class, saying that, “Anytime I can bring in manipulatives and make it concrete for them, that’s what I like, to do a lot.” In terms of students, Kate describes how she uses the, “emotional temperature of the classroom,” and, “how the students are reacting to a lesson,” as a means to make decisions about how she will present instructional content. As she explains, “You know, I’ve got groups that hate hands-on activities... and I’ve got groups that do worksheets.” This is something Kate thinks about with respect to each of her classes and helps her make decisions that tailor her instruction to the students with the intent of motivating them to learn. Kate also describes using planning and research, particularly internet-based resources, to find engaging activities and instructional techniques to motivate her students to learn. She uses Estimation 180, YouTube videos, and Figure This! to design engaging warm-ups and other websites, such as Math Equals Love and the Mathematics Assessment Project, to locate activities and find instructional

techniques that might be used to engage and motivate her students to learn. For example, when describing how she worked through motivating an individual student to learn she used her research and planning, understanding of the student, and appropriate materials to mediate the dilemma of finding ways to present instruction that would motivate this student to learn:

Okay, so I have this student. He's a junior in Geometry and he will just tell you what he thinks. He's just, loud, doesn't like school, and doesn't like math, and he doesn't like any of his teachers. And uh, he came in and we got along okay, but getting him to work is little, we get along, but he still is posted over there not doing a whole lot. So, I started having a class a day in the flex block and I noticed that he loves these YouTube videos where these people are building primitive water slides, a pool, and sometimes it's a building and they just use like bamboo and clay and they make their own bricks and stuff, and it's really cool. He loved those videos, so I thought if I could turn this into Geometry, I wonder if I could get him to do it. And so, I took one of those videos and we turned it into a geometry lesson and that was probably the first time I've had him engaged all year. I mean, just finding what he likes, you know, like, it's about a four-wheeler or something. Then he'll have to pay attention and listen. It's still not going to be all in, but he's gonna listen later.

The culmination of these resources helps Kate to be confident that she has done everything she can to motivate her students to learn and, while not resolving, she is able to make progress in working with this dilemma.

When working through how to present content to support the understanding of a variety of learners, Kate finds that her students and research and planning act as primary resources that guide her actions in this dilemmatic situation. There are many ways a teacher can present content to students, but Kate has found that her understanding of student thinking and motivation inform how she goes about making decisions about instruction. She describes:

A lot of times, especially in special ed., where everybody is all on different levels and we may have one who can master this in a day, where others may take two weeks, and keeping the ones who are so much further ahead engaged while not letting those who are so much further behind give up. And trying to find that balance, it's exhausting. And then really, it's just how I pace my lessons and grouping helps a lot, because a lot of times the way I group students is by ability level. That way I can bridge those who have already got it and they can move on, not necessarily for the goal of practice on a higher level while those who are really struggling can still practice those skills too. Sometimes I'll put my really high with my really low one's and they can feed off of each other, sometimes that helps.

She also says:

I keep up with around 60, and you're definitely gonna have to at least lead them through a little bit more. It's going to be a lot more guided. It's going to be very much more, a lot of the abstract thoughts haven't developed yet for them, they are a little behind on that. So, it's definitely gonna have to be explained a lot more

thoroughly. It's probably going to take a lot more time. What will probably take one day from one class, it's going to take two for mine.

These two passages show how Kate considers her students as a resource to inform how she thinks about presenting instruction. She is using her understanding of student thinking and to mediate the tensions that arise in her decision making about presenting content.

This dilemma is further mediated by her research and planning, particularly reading blogs and searching mathematics-based websites to find materials and strategies to meet the needs of a variety of learners. In particular, Kate describes how the Mathematics Assessment Project provides a narrative, along with an activity and sample student work, that helps her make sense of how to differentiate and support a variety of learners.

Summary. Kate's conceptualization of resources and description of dilemmatic situations illustrate a teacher who is using everything she can think of to support her teaching and her student's learning. It is also apparent that her desire for students to find success and support student thinking helps guide her decision making in-context-in-practice. Figure 5 summarizes the mediating relationships resources have with the dilemmas Kate experiences and the decisions she makes in-context-in-practice that were laid out in her individual description.

Teacher #5: Donald

I first met Donald as part of this study in the Spring of 2019. He joined after the study initially began, as I was introduced to Donald by Judy. I was interested in asking Donald to participate since this was his first semester teaching. This would provide a

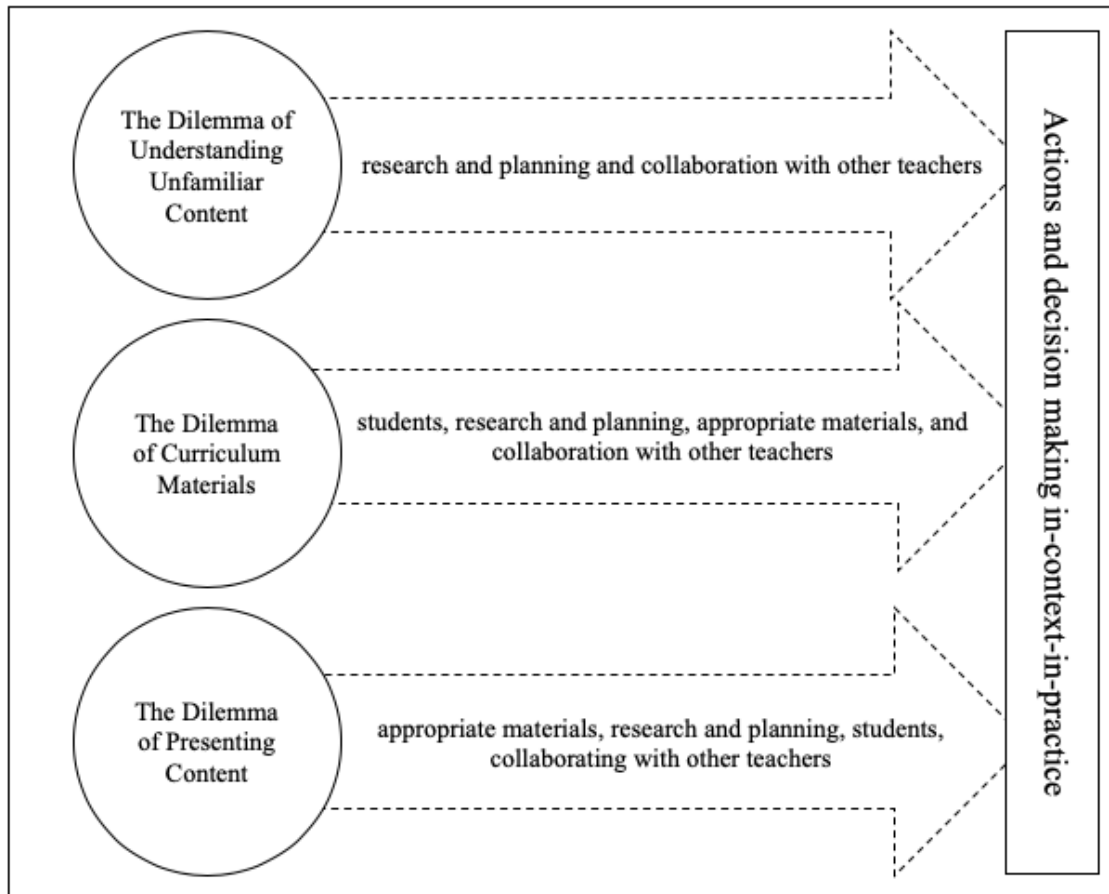


Figure 5. Overview of Kate's resources mediating dilemmas.

unique perspective on dilemmas and resources that are experienced by rural secondary mathematics teachers. I was appreciative of his acceptance to participate.

Dilemmas. The dilemmas Donald experiences are described in two categories: the dilemma of sustaining student engagement and the dilemma of presenting content.

The dilemma of being creative and sustaining student engagement. As a first-year teacher, Donald finds it to be dilemmatic to engage students. He wants to have students work together, because he believes they can learn from each other, and engage with the material, but often finds this not to play out as he intends in the classroom. Throughout the study, Donald says things like, “I’m trying to find different... ways to get them started, get them engaged, and get them actively participating,” “I want to get more creative [in the classroom],” “find something creative [to do in class],” “I want to implement things in my room like games... stuff that would get them engaged and get them going,” and, “I’ve tried a lot of different tricks to get them engaged, and I can’t get them to engage.” Donald says that he is trying a lot of things, but often finds that time, having lack of experience, and other demands of being a teacher don’t let him be creative enough to sustain student engagement. He finds himself wanting to creative and innovative things in the classroom, but in reality, he sees that he is lecturing and teaching in a way that exists in contradiction to his expectations.

The dilemma of presenting content. Donald experiences the dilemma of presenting content in two ways. The first is through tensions created when deciding what he should be teaching. The second is through tensions created by deciding how to best support student understanding during instruction.

First, Donald feels a tension between what he should be teaching and what he is teaching, on a day-to-day basis. As he describes, he is still a new teacher, “still trying to learn exactly what needs to be taught.” Additionally, in talking about this tension, he describes feeling like he has to “slow down” when teaching his classes because he has a lack of confidence in students’ abilities. He also describes how he had planned to start on Chapter 10 when he began teaching the class in the middle of the school year but ended up teaching from Chapter 1. This was not a decision he made lightly, but rather it was a decision that he described as coming to at the result of reaching out to accessible resource and as being necessary to be able to help students be successful in other sections of the curriculum. This decision adds to the dilemmatic situation as he attempts to integrate pacing guides, outlines, and other curriculum-based materials into his work and prepare students for completion of the course and to be successful on their state assessment.

Second, Donald experiences a tension when presenting content in the moment. For instance, he describes a situation when teaching factoring, where he found himself experiencing, “a huge problem,” where he knew one way to factor but not ways that would support student learning. He describes how he “had to kind of adapt on the fly,” because, “the way [he] was teaching it didn’t work.” Not being able to discern what was the effective way to teach factoring in a way that supported student understanding created a tension for Donald where he found himself adapting and making compromises with what he was expecting to be doing in the classroom. Donald also describes this dilemma when he discusses highlighting critical information for students. He finds himself trying to “break it down and explain to [the students] why it’s important,” and often saying to the class, “Guys, hush, this is important.” But these means create challenges for Donald

in making sure that students are understanding the important information and why it is relevant to what they are doing in class.

Resources. Five categories describe Donald’s conceptualization of resources for the teaching and learning of mathematics: experience, colleagues, the internet, student interactions, and school materials.

Experience. Donald describes experience in two ways—personal and teaching experience. In terms of personal experience, Donald is relying on his experience as a student in high school and at the undergraduate level. He refers to “when I was in high school,” “the way I was taught,” and, “the way they taught all of us in college.” These experiences are a resource that he is able to draw on in his practice to inform how he acts and makes decisions.

Additionally, when talking about teaching experience, Donald talks about his colleagues and the informed experience they bring to his practice. Donald says:

They're experience is significant to how I do it, because, like I said, first year teacher, I'll take all the experience I can get. Judy, Danerys, Cersi, and even Christa, even though she's only been [teaching a couple years], she's still got some more experience under her belt that I do. I take a lot of their feedback and combine it and I'm like, okay, let me try, let's try this with a student.

Donald values the experience of others and uses this experience as a resource for his practice. Often his colleagues experience is shared through informal conversations that happen over lunch and throughout the school day, but he says:

Their experience is very helpful because I know without a shadow of a doubt that they know more about it than I do. So just to get their, get their feedback and like, "Okay, this is where I'm at with the student. What do you guys recommend?"

Colleagues. When talking about colleagues, Donald describes both local colleagues in his school and those that he met during his undergraduate studies. From his undergraduate studies, Donald talks about reaching out to a friend when first starting his semester:

I love talking with, um, one of my friends from college, Carla. She teaches over in another county, and me and her talk all the time. I'll talk to her and be like, I mean I even borrowed her syllabus and I was like, "Hey, and I'm still struggling with the syllabus. Can I borrow yours?" And she did, we exchanged it and it went really well. But yeah, she's been helpful so much to me, you know, giving me advice. Because this is her second semester teaching, so she's been giving me tips and tricks and stuff. Um, that's been very helpful.

In addition to colleagues out-of-district, Donald describes how Judy, amongst others in his school, have shared curriculum materials to support his practice. He says, "I like using [Judy]," and how talking with Judy and Christ is great because they, "have so many good ideas... I love talking to them about it."

Colleagues, both in and out of the district, are a resource that Donald uses to inform his practice and professional decision making.

The internet. The internet is a vast resource that Donald tries to make sense of and use to inform his actions as a teacher. Examples of this are when Donald describes planning and how he will, "Google 'function lecture' or 'function high school lecture,'"

or, “do a Google search for ‘factoring help’ or ‘factoring notes,’ or something like that.” In addition to Google, Donald describes how he uses Teachers Pay Teachers to access pre-made materials and finds videos on mathematics content and teaching mathematics through YouTube and mathematics teaching websites.

Student interaction. In describing student interactions as a resource for the teaching and learning of mathematics, Donald talks about, “interactive sessions.” For Donald, interactive sessions are where the students are interacting with the material. As an example of an interactive session, Donald talks about, “the Bingo thing where you’re doing math, but you’re interacting with it,” and shifting note taking from traditional writing to more of a foldable activity. Donald also talks about student interactions by way of groupwork. He talks about groupwork in terms of how students are able to help each other and how he might not teach it the best but by working in groups students can figure it out:

I could say something to you until I'm blue in the face and you won't get it. If you don't get it then you're lost, but if I get peer and pair you up with someone and they explain what I said. So, if they can give them another route to go about it and they can give them another way that they can learn, get the same materials, same content, do the same thing. If they can show them a way and break it down, that's why I love group work. It just helps them to get on their level, because my guess is, this is what I've seen, if one student is struggling with it, if I pair them up, they can explain it another way. Same name, different way of doing it works for me. As long as they get the right answer at the end of the day. That's why I love group

work. It just helps to see them from another level, see them from another point of view.

School materials. School materials include both technology and non-technology school materials. Here, Donald talks about technology materials in terms of his interactive whiteboard and slate. Non-technology school materials include his textbook and curriculum materials he is able to find on the internet and gathers from colleagues (e.g., pacing guides, state standards, and pre-made notes and PowerPoints).

Resources as mediators of dilemmas. Donald's conceptualized resources—experiences, colleagues, the internet, student interactions, and school materials—each play a mediating role in the dilemmas he experiences—the being creative and sustaining student engagement and the dilemma of presenting content. Findings on the role of Donald's resources as mediators of the dilemmas he experiences is explored in the following sections.

Mediating the dilemma of being creative and sustaining student engagement. Donald is aware of the dilemma of student engagement. He wants to be the engaging teacher that he never had as a high school student himself. In describing his experience as a student in contrast to how he wants to teach, Donald says:

They just taught, lectured, gave an assignment, and called it a day. I don't want to be that teacher. I want to be who is just so much fun. I just want to come in and have so much energy and I don't want to be just a guy who stands up and talks the entire class. I don't want to do that. Am I doing it? Kind of. I just don't want to be that guy. But that's what I'm trying to work on.

This exemplifies Donald's experience with this dilemma, and in terms of using resources to mediate the dilemma, he relies on the internet, his colleagues, and his personal experiences.

Throughout the study, Donald discussed trying to be more creative in the classroom so that he could sustain student engagement throughout a class period. To be more creative and engage his students, Donald uses the internet, mainly Teachers Pay Teachers, "That is really helpful in making me a more creative and not another worksheet teacher, you know?" He also says:

Sometimes I'll go on Teachers Pay Teachers. I love going on there and trying to find little activities for them to do. Like, if I encounter a topic, if I have time, I'll try to go online and find something creative.

In addition to Teachers Pay Teachers, Donald also uses Google as a resource to find websites that have creative approaches to instruction that he thinks will be effective in engaging his students, and searches for videos of other teachers who are discussing how to teach a specific skill—citing the Kahn Academy and "a couple [teachers] out there" on YouTube.

Donald also uses his colleagues and personal experiences to mediate this dilemma. He thinks about his undergraduate experiences in teacher education to draw on ideas to engage students and be creative. However, since Donald moved for the job in the middle of the year (i.e., started in January 2019), he has left many things behind, including a notebook of many of the things he experienced as an undergraduate student. Donald describes thinking about the strategies and ideas in his notebook, but also tells me that it is something he needs to "bring down," so he can use it effectively:

I've also got my college stuff. I kept everything, all the projects, I got a big strategy notebook that I put a bunch of strategies in, which I need to bring down. Um, but I do, I do think about [college and the notebook] a lot when I go in and I'm trying to think of strategies.

In addition, Donald says that colleagues are helping him be creative, work towards engaging the students and mediate this dilemma. He describes receiving PowerPoints and other materials from colleagues in and out of his school (e.g., Carla, Judy, Christa) that help him avoid doing a lecture that he finds disengages the students.

Mediating the dilemma of presenting content. Donald often finds it tenuous to make decisions about presenting content, both when making decisions about what he should be teaching and in supporting student understanding during instruction. This occurs because Donald says, “The biggest challenge from planning is actually that I don't have nothing right now.” Not having a set of curriculum materials to build on and think through has placed Donald in the situation where he is debating amongst himself what he should be doing and how it should be done. As he is working through this dilemma, Donald relies on his colleagues and their experiences, the internet, school materials, and student interaction to mediate this dilemma.

Donald uses his colleagues to both gather materials he can consider using and to make decisions about what to teach and how to teach it. In terms of what to teach, Donald talks about how Judy helped him decide to start at Chapter 1 instead of Chapter 10. He relied on her experience, trusting that she knew best:

One of the biggest things that helped me [at the beginning of the semester], was Judy. I was planning on starting on chapter 10 and she was like, "Whoa, no, no,

you can't do that. You're going to have to go back to chapter one because of the situation that we're in."

He goes on to describe how Judy and Christa help him understand how to present content in class to support student understanding:

So other teachers, I love talking to other teachers about it. Even like, I'm like, "Okay, I can't get him to do this." And [Judy] was like, "Well, maybe try this." I love talking to fellow math teachers about it, especially her, because she has so many good ideas. Um, her and Christa have so many good ideas and I love talking to them about it.

These are instances when colleagues help Donald make decisions about what to teach, but he also relies on them when making decisions about how to present content to support student understanding in-the-moment. The following excerpt describes how Donald uses lunch as a time to reach out to colleagues during the school day:

Where I'm a first-year teacher, this is a whole new ballgame, I go to my colleagues. I love to do this during our lunch, and I hate to keep talking about it during our lunch, but I need their help. I'm like, "Guys, I got this student, who I cannot get this to do this." And I explained the situation and they'll offer suggestions, like, "I tried this with one student one time, it worked." They're experience is significant to how I [present content in class], because, like I said, first-year teacher, I'll take all the experience I can get. Judy, Danerys, Cersi, and even Christa... I take a lot of their feedback and combine it and I'm like, okay, let me try, let's try this with a student. It didn't work. Well let's try what Danerys said, or what Judy said, or what Cersi said. I just, I try a bunch of different things.

Um, so colleagues, their experience is very helpful because I know without a shadow of a doubt that they know more about it than I do. So just to get their, get their feedback and like, "Okay, this is where I'm at with the student. What do you guys recommend?" So, it's very helpful and I've gotten a lot of help from all of them this semester.

In addition to colleagues, Donald turns to the internet and school materials to mediate this dilemma. He finds teaching strategies on the internet through Google searches, on Teachers Pay Teachers, and video channels that have someone teaching a mathematics concept. He also uses his textbook to understand what he should be teaching and how to support student understanding of the content, and, for Donald, the textbook was the first resource he thought about when describing what makes him good at his job. He describes the textbook as a good overview of what should be taught and thinks of it as a launching point for his decision making about presenting content:

First thing I chose was textbook because new teacher, still trying to learn exactly what needs to be taught. Yeah, I was taught it but that was five, six years ago. So textbook helps guide me with what I need to teach. This is the content I need to cover. It just helps me to see that and then I can go from there.

In addition to the textbook, school materials, like his interactive whiteboard, are critical to helping Donald present instruction and make decisions about presenting content during instruction:

I cannot teach without, to me, in this day and age, and plus the way I was taught, I can't not teach without technology. Um, because for me technology is still useful. I can write on there, I can save it, I can print it out and give it to students who

missed. Technology is so good because, and also because, um, I can easily switch colors if I want to make something in red or highlight something. It's hard to highlight on a whiteboard. But technology is just so key to me in helping me to be able to be more visual with the way I teach, and it makes me, it gives me more options essentially to how I can teach. Instead of having to just use all black on a whiteboard, I can use that [interactive whiteboard] there and I can do so much more with that than I ever could with a whiteboard.

This piece of technology helps Donald more options for how he can teach and allows him to be more visual and draw student's attention to specific aspects of the mathematics they are working on to support their understanding during instruction.

Additionally, while technology may help mediate this dilemma, Donald also draws on student interaction to work through the dilemma of presenting instruction. When presenting content, Donald is aware that his strategies may not be effective in supporting student understanding and believes that group work is a means to "get the point across" to all students. As he says, "Maybe I didn't teach the best, but it's groupwork. They [see the material] and what I taught, they can add on to it and go from there." This allows Donald to move around the room and support different groups while also providing the student with the opportunity to understand the content from another students' point of view. The following excerpt describes how Donald thinks about student interaction as a means to mediate student understanding when presenting content in class.

I could say something to you until I'm blue in the face and you won't get it. If you don't get it then you're lost, but if I get peer and pair you up with someone and

they explain what I said. So, if they can give them another route to go about it and they can give them another way that they can learn, get the same materials, same content, do the same thing. If they can show them a way and break it down, that's why I love group work. It just helps them to get on their level, because my guess is, this is what I've seen, if one student is struggling with it, if I pair them up, they can explain it another way. Same name, different way of doing it works for me. As long as they get the right answer at the end of the day. That's why I love group work. It just helps to see them from another level, see them from another point of view.

Summary. Donald's conceptualization of resources and description of dilemmatic situations illustrate a teacher who uses experience, colleagues, the internet, student interactions, and technology and non-technology school materials as primary resources to mediate the dilemmas he experiences. It is also apparent that his desire to be a creative and engaging teacher drives his decision making but is also balanced out by his limited time being a secondary mathematics teacher. Figure 6 summarizes the mediating relationships resources have with the dilemmas Donald experiences and the decisions he makes in-context-in-practice that were laid out in his individual description.

Cross Case Analysis

The sixth section of this chapter shifts the focus from the individual to the collective, providing findings from a cross-case analysis. Each of the following sections highlight significant commonalities and differences in the RSMTs' experienced dilemmas, conceptualization of resources, and mediating role of resources on the dilemmas they experienced. In analyzing the participants as a whole, the following

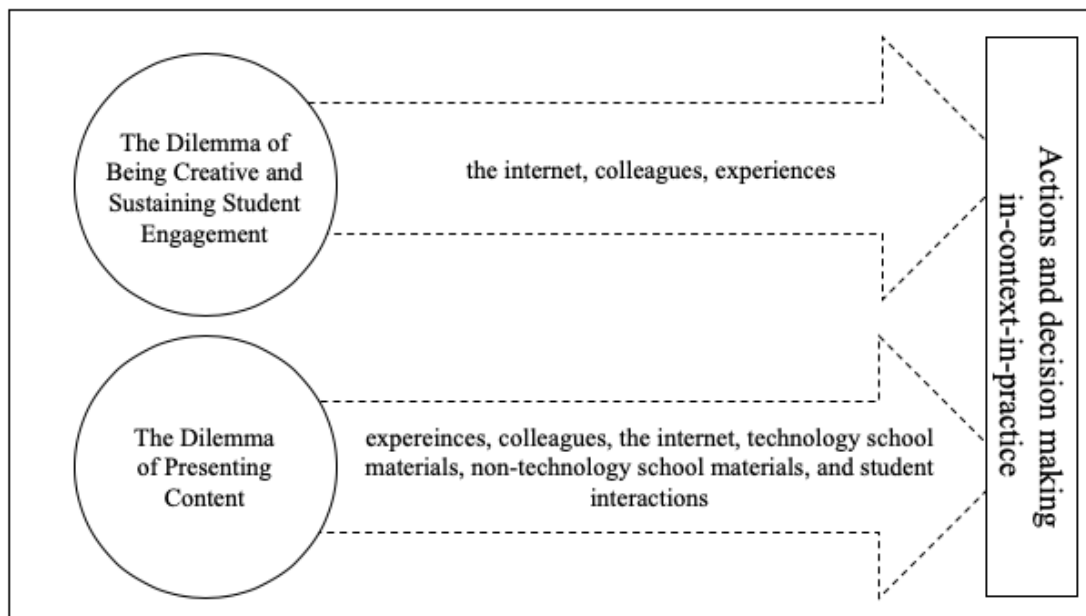


Figure 6. Overview of Donald's resources mediating dilemmas.

sections draw on categorical aggregation (Stake, 1995) to describe the commonalities and bring focus to significant differences that were noticed between the participants.

Resources. After first uncovering the individual RSMT resource conceptualizations, overarching categories were developed that tried to stay true to the sum of the participants' vernacular. As a result, six categories were developed in relation to resources the RSMTs conceptualized—school materials, curriculum materials, other teachers, experience, and students (Table 4).

School materials. Within the category of school materials, the RSMTs talked about three types—basic school materials, school mathematics materials, and technology.

- Basic school materials comprise of items like a chalkboard, whiteboard, poster board, markers, individual whiteboards, and glue.

Table 4. Summary from Cross-Case Analysis of Resources.

	Sarah	Judy	Christa	Kate	Donald
School materials	School materials	Technology	School materials	Appropriate materials	School materials
Curriculum materials	Curriculum materials	Curriculum materials	School materials	Research and planning	School materials
			Data, standards, and past experiences		The internet
Other teachers	Relationships	Collaboration	Other Teachers	Collaboration with other teachers	Colleagues The internet
Experience and Knowledge	Knowledge	Experiences	Students Data, standards, and past experiences	Students	Experiences
Students	Knowledge Relationships		Students Formative assessment	Students Formative assessment	Student interactions

- School mathematics materials include mathematics manipulatives, math journals, calculators, student dry-erase boards with a coordinate plane, and mathematics practices themed bulletin boards.
- Technology consists of interactive whiteboards, personal laptop computer, wireless slate, web access, mobile laptop carts, document camera, computer programs (e.g., PowerPoint, Flipchart, Word), and web-based platforms (e.g., Desmos, Kahoot, Plickers).

Curriculum materials. In conceptualizing curriculum materials, RSMTs consider a wide range of materials to be considered a resource. These items can be categorized in four ways—personal and peer-made curriculum materials, district provided curriculum materials, state provided curriculum materials, and curriculum materials found on the internet.

- Personal and peer-made curriculum materials include collections of presentations (e.g., PowerPoint, Flipchart, and Smart Notebook), guided notes, individual and group activities, and worksheets, each of which are created or adapted and then stored with a digital copy that can be reused and changed at a later date.
- District provided curriculum materials encompasses the current course textbook and workbook, previously approved course textbooks and workbooks,
- State provided curriculum materials includes grade-level or course curriculum standards, sample end of course assessment items and practice tests.
- Curriculum materials found on the internet consists of state Department of Education developed websites (e.g., Louisiana Believes, Engage New York, and Tennessee Core), general education websites (e.g., Teachers Pay Teachers),

mathematics education related websites (e.g., Desmos, YouCubed by Dr. Jo Boaler Math Equals Love by Ms. Sarah Carter, Math Giraffe by Ms. Brigid, a variety of Three-Act-Math and mathematics inquiry based websites by mathematics educators like Dr. Dan Meyer and Andrew Stadel Math and the National Council of Teachers of Mathematics' Illuminations and Figure This!).

Other teachers. In talking about other teachers as a resource, across the cases the RSMTs referenced other teachers on the internet and those they could meet or talk with one-on-one. In talking about other teachers on the internet, RSMTs talked about reading mathematics teacher blogs, articles, and lesson plans or watching a video instructional lesson, reflection, or content-refresher on the internet. Though the RSMT's may not have had a teacher they could use as a resource next to them, they were able to connect with other mathematics teachers through the internet. This is best exemplified by Sarah, Christa, and Donald, who utilize the internet most frequently as their collaborator. However, each of these teachers did use the internet to connect with other teachers about the teaching and learning of mathematics.

The RSMTs also utilized their school- and community-based teacher networks as a resource. Across the cases, each of the RSMTs discussed reaching out to teachers in their school. Kate talked about reaching out to her general education counterpart, Judy, Christa, and Donald discussed collaborating with each other, and Sarah talked about her grade-level co-teachers and grade-level PLC group as other teachers she considered a resource. Additionally, participants like Sarah and Donald continued to reach out to mathematics teachers they had previously developed relationships with through teaching and undergraduate teacher certification.

Experience and knowledge. Throughout the data, the RSMTs referenced their experiences and knowledge as a resource for their practice. In doing so they would mention their experience being a student (Donald), being a tutor (Sarah and Judy), and teaching (all RSMTs) as being a resource that informed their practice. In addition, four of the five RSMTs had been teaching more than one year and each of those four discussed professional development opportunities as a resource that informed their work. Experience was also a resource that Donald viewed as pertinent to informing his decision making; often relying on Judy and Christa's informed experience and recommendations to support his actions and decision making.

It also appeared that these RSMTs experiences, or experiential knowledge, a type of local knowledge about mathematics teaching and learning that stemmed the local institutions and context. Experience had provided these RSMTs with a knowledge that placed a lack of confidence in student abilities and informed expectations for instruction. There was also an experiential knowledge that informed the content and pedagogical knowledge from the RSMTs classroom teaching and tutoring experience. Knowledge was also noticed apart from experience when the RSMTs talked about having a content knowledge for teaching mathematics that led to a flexibility in how students might go about solving a problem and a pedagogical content knowledge that led to flexibility in how they might go about teaching a particular topic.

Students. Students as a resource was noticed across the RSMTs in two ways—understanding students content knowledge and students interests and attitudes in relation to mathematics teaching and learning. This is best exemplified when the RSMTs discussed using their understanding of student's mathematics content knowledge as a

resource to inform their decision making and actions with respect to the teaching and learning of mathematics. For instance, Christa discussed using a variety of formative assessment techniques (e.g., questioning, whiteboard practice, and fist-to-five) and Sarah discussed using games to inform their actions and decisions as teacher's. In addition, the RSMTs discussed how they would use their knowledge of student interest and attitudes to tailor instruction. This was best exemplified when Kate discussed finding videos on YouTube that related to what one or a few of her disengaged students were interested in to launch lessons and introduce mathematical topics and concepts.

Significant differences. This section highlights three significant differences that were noticed across the cases in relation to resource conceptualization. First, Sarah conceptualized her dispositions as a resource, and though it is not placed in the categories above, it is relevant as her character and mentality towards teaching were significant resources that she found important to discuss. Even though the other RSMTs did not necessarily bring up dispositions as a resource it was hinted at in some of their statements. An example of this is when Kate describes “going the extra mile” and letting students know that she cares about them both a learner and person.

Second, it's important to note that experience is a central resource for these RSMTs. Each consistently recalled past experiences teaching and working with students, but what was unique was how Donald valued other teachers' experiences and recommendations over his own thinking about effective mathematics instruction and understanding of students. This was noticed as Judy's experiential knowledge and beliefs about students was central to informing Donald's decision making about the teaching and learning of mathematics as he began his career at Mountain Range High School.

Finally, it's important to note that while the section "Resources" within the cross-case analysis is defining categories across the RSMTs, one might also use years of experience as a distinguishing factor and note that the resource conceptualization of Donald differs from that of Christa and Kate, which also differs from Sarah and Judy. Showing how personal teaching experience can play a central role in how teachers view resources at the beginning of their career versus after ten-plus years.

Dilemmas and resources as a mediator. Across the individual RSMTs, there are two overarching categories of dilemmas that will be described from the cross-case analysis. These dilemmatic categories are in relation to (1) ambitious teaching and (2) curriculum materials. Table 5 shows where each of the dilemmas the RSMTs described were categorized following the cross-case synthesis.

The following two sections will discuss each of the dilemma categories and the three of the most critical resources that supported dilemma mediation. A final section will discuss significant differences between the RSMTs.

Ambitious teaching. Ambitious teaching can be described as the teacher striving to enact professional actions and mathematics instructional practices that support students' attainment of conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (Kilpatrick, Safford, & Findell, 2001). Thus, on the surface, this category of dilemmatic situations appears to act as a catchall of dilemmas of practice. Particularly as it brings together RSMTs' dilemmas related to supporting student understanding (Judy), presenting and understanding content (Kate and Donald), and ambitious teaching (Sarah and Christa). However, by viewing this dilemma from the RSMTs' perspective, it makes sense that the

Table 5. Summary from Cross-Case Analysis of Dilemmas.

	Ambitious Teaching	Curriculum Materials	Control
Sarah	The dilemma of ambitious teaching	The dilemma of curriculum materials	The dilemma of control
Judy	The dilemma of supporting students' grade-level understanding of content The dilemma of unplanned school closures	The dilemma of curriculum change	The dilemma of unplanned school closures The dilemma of curriculum change
Christa	The dilemma of ambitious teaching	The dilemma of using technology	The dilemma of using technology
Kate	The dilemma of understanding unfamiliar content The dilemma of presenting content	The dilemma of curriculum materials	
Donald	The dilemma of being creative and sustaining student engagement The dilemma of presenting content		

dilemma of ambitious teaching would encapsulate a variety of actions and decisions teacher's make on a day-to-day basis.

With respect to dilemmas surrounding ambitious teaching, two key factors are highlighted by the data that seem to create challenges and tensions around trying to teach in an ambitious manner. First is that the RSMTs lack a confidence in students mathematics ability. These teachers seem to have a deficit view towards what students are capable of achieving in their class and causes the teachers to second guess whether or not they will be successful at activities and lessons that they find on the internet, seek out from peers, or find in their course textbook and workbooks, furthering the tension in their actions and decision making. A second factor that created tensions and challenges for the RSMTs to teach mathematics ambitiously is unplanned school closures. At the time of data collection, the entire school system missed a plethora of days due to snow and ice, flooding, and sickness. This created a tension where teachers had to make decisions that had them balance getting through the curriculum in time for an unchangeable state assessment date and time spent in class on assessment, group work and activities that help uncover and support students' mathematical proficiency. When combined, a lack of confidence in student abilities and a substantial amount of unplanned school closures perpetuate a feeling of, "undershooting for the kids," says Christa—a feeling apparent throughout each of the RSMTs data.

In mediating this dilemma, across the RSMTs, the three most critical resources were other teachers, the internet, and knowledge and experiences. Other teachers helped by providing curriculum materials and sharing their experiences when struggling to support students grade-level achievement and working with students who they lack

confidence in their mathematical abilities. In addition, collaborations with other teachers helped mediate some of the challenges and tensions that came with the school closures. Discussing changes and finding ways to adapt and cope with the unpanned school absences helped these RSMTs be comfortable with what they were doing in the classroom, as they were doing their best. The internet also acted as a significant resource for the RSMTs in mediating this dilemma. For instance, the internet provides access to lessons, blogs, and articles that these teachers read and think about in relation to supporting struggling learners while still teaching ambitiously. An example of this is when Kate would use the Mathematics Assessment Project website to find high-quality activities for her intervention class. She has access to a narrative about how the lesson/activity might play out in the classroom and can read and go over sample student work and ideas for differentiation. While Kate says that she has to make adaptations for her classes, typically around the amount of time they have to do the activity, she does try to keep the rigor at a high level, while supplementing and teaching between parts of an activity when she sees fit. Finally, these teachers all draw on their knowledge and experiences teaching mathematics, including the knowledge and experience of their peers, to inform their decision making and actions with regards to mathematics teaching and learning.

Curriculum materials. For the RSMTs, their conceptualization of curriculum materials includes personal and peer-made curriculum materials, district provided curriculum materials, state provided curriculum materials, and curriculum materials found on the internet. One reason that these RSMTs make use of a variety of curriculum material sources is in response to state curriculum and assessment practices consistently

being in flux. This causes the teachers to lack confidence in the quality, rigor, and connectedness of curriculum materials they are being provided by their district (e.g., textbooks, workbooks, mathematics programs) to ever changing expectations. In addition, a lot of educational advancement and new programs have a significant online or computer-based feature. However, the RSMTs do not always have access to the technology to support student use of these innovative features in the classroom and students lack access to the internet and technologies at their homes.

These challenges and tensions bring together the dilemma of curriculum materials (Sarah and Kate), the dilemma of curriculum change (Judy), and the dilemma of using technology (Christa) under the same umbrella of the dilemma of curriculum materials. Where RSMTs may find something online that they would like to use in the classroom but are unable to do so due to a lack of access to technology or an unreliable internet service provider. These teachers may understand the intentions of curriculum and assessment changes but not be aware of how that would go about changing their instructional practices. Thus, these teachers often have a lack of reliability and accessibility with respect to that which they have access.

Three significant resources that mediate this dilemma of curriculum materials are the internet, other teachers, and school materials. First, the internet acts as a tension creator and mediator within this dilemma. Teachers may not have confidence in the quality of their textbook, so they go online to find curriculum materials they believe would match the quality and rigor of what is being expected. However, these teachers must then also make sure that they are able to effectively implement what they find online. For instance, Christa describes finding lessons and activities online that use

Desmos, an online graphing calculator, and Geogebra, an online geometry learning platform, but then running into issues with the technology and implementation in her classroom. The RSMTs also use other teachers to mediate this set of dilemmas. Other teachers in the school, community, and online, provide dialogue to help make decisions about appropriate curriculum materials and often can share lessons and activities that they have found, received, or made themselves with each other. Finally, school materials help mediate this dilemma. When issues of one-to-one technology arise, many of the RSMTs talked about turning an individual activity into a whole group activity, using the interactive whiteboard as the focal point of innovative technology use. In addition, these RSMTs talked about using individual whiteboards, math journals, and mathematics manipulatives as a means to uphold rigor and use curriculum materials when items they have been provided do not meet the quality of instruction and provide the learning opportunities necessary for meeting the expectations that come with curriculum change.

Control. Across the data from the RSMTs, they appeared to be experiencing to be an overarching dilemma of control. This dilemma was experienced by Sarah when she had challenges with control over assessment practices and participating in PLCs with other grade-level teachers, Judy when she discussed the challenges and tensions that come with curriculum change and unplanned school closures, and Christa and Kate when they intend to use technology but are not sure of its availability in the classroom.

Overall, the RSMTs saw a lack of control of their professional practices because outside forces (e.g., weather and the expectations of school-based administrators, district-wide administrators, and state-wide policy makers) created tensions that either forced change or caused the RSMTs to act in ways that they found contradictory to what they saw best.

This is best exemplified by Sarah who participated in PLCs that she found being nothing more than teachers meeting to fill out a PLC meeting form, provided by the school administration, “professionally.” Looking across the RSMTs it is observed that state-wide curriculum changes have also caused these teachers, particularly the more experienced RSMTs, to feel a lack of control in their practice. In general, these teachers have a vision for how things should be going, but often feel like they have a lack of control over the process.

The three significant resources that mediate this dilemma of control are teaching experience, relationships and collaboration with other teachers, and the internet.

Significant difference. There is one significant difference that was noted during the cross-case analysis. Similar to the significant difference described for resources, t’s important to note that years of experience is a distinguishing factor to the type of resources one seeks out and makes use of when experiencing a dilemmatic situation. For example, Donald, a first-year teacher, tends to rely on his textbook, the experience and wisdom of others, and the internet when working through challenges and making decisions. Kate and Christa, fourth- and third-year teachers, have almost entirely abandoned the curriculum materials they have been provided, making use of them as more of a tool to see the broader picture of the mathematics curriculum. Then, Christa and Kate supplement their curriculum materials with things they have used in the past, things shared from other teachers, and things found on the internet. Finally, Sarah and Judy, both who have taught more than thirteen years, also have largely abandoned what has been provided by their district. However, rather than seeking out more materials,

they rely on things they have previously used and their knowledge and experiences to support their decision making and actions.

Summary

First, recall the research question and sub-questions. The research question guiding this study is: *How do mathematics teachers in rural settings make use of resources to mediate and manage dilemmas in practice?* To help unravel this question two sub-questions were formed to help guide the analysis:

1. From the teachers' perspective, what are the dilemmas of practice that mathematics teachers in a rural setting experience?
2. How do mathematics teachers in rural settings conceptualize resources for the teaching and learning of mathematics?

Throughout Chapter 4 are detailed answers to the research question and sub-questions based on the individual participants and across the participants of this dissertation study. While these descriptions serve as the primary answers to the research question, this final section highlights key insights that unfolded through the data analysis process (see Table 6 for a summary of the key findings).

Research sub-question one. Based on the data analysis, RSMTs experience dilemmas that both vary and converge. Though experiencing specific dilemmas that are unique to the individual, it is apparent that as a whole the RSMTs experience dilemmas that relate to ambitious teaching, curriculum materials, and control. As the analysis unfolded it was evident that many of the dilemmas the RSMTs experienced stemmed from three tenuous and challenging situations they were perceiving:

1. The curriculum and assessment expectations and documents are consistently in flux.
2. The curriculum materials provided by their district are not aligned and rigorous enough for the state curriculum and assessment expectations.
3. The RSMTs have a lack of confidence in students' mathematical abilities.

It was not that the RSMTs did not believe they could teach the material, but rather that they were in a situation where they were ill prepared to support struggling students and teach in a climate of constant curriculum change.

Research sub-question two. From the data collected and analyzed as part of this study, it is evident that RSMTs have different conceptualizations of what constitutes a resource they utilize in their practice. While the resource conceptualizations differed, they also have some commonalities. Of particular note is how the resource conceptualizations of Sarah, Kate, and Christa differed from Donald and Judy. All of the RSMTs showed evidence of school materials and curriculum materials as part of their resource conceptualizations, but the attention to students as a resource stood as a nuanced difference. Focusing on relationships with students, understanding and uncovering student thinking and dispositions, and building classroom community indicated a salient difference in what these RSMTs saw as resources to inform their practice and, in turn, mediate the dilemmas they experienced.

In addition, the internet, virtual curriculum materials, and technology play a significant role in the RSMTs conceptualization of resources. Access to the internet lets Donald observe strategies to teach content, Christa an avenue to connect with other teachers through blogs and articles, Judy and Sarah a place to search and find relevant

curriculum materials, and Kate the opportunity to find ways to work with her intervention class while still providing rigorous and high-quality activities. In addition, it is important to note again that the internet acts as a vital resource that helps bridge funding gaps that otherwise would limit student and teacher access to high-quality curriculum materials and affords the RSMTs opportunities to interact with other teachers in ways that are not always afforded in more personal collaborations. The internet is also a critical resource that affords teachers to make sense of curriculum changes at their own pace and based on their own understanding. When talking about the internet they described their use of it as “research,” finding everything they can to best support their students because their context restricts their physical access to often outdated and disjoint materials.

Overall, across the cases, the RSMTs resource conceptualization was synthesized into six salient categories—school materials, curriculum materials, other teachers, experience, and students.

Research question. The overarching research question guiding this study asks, *how do mathematics teachers in rural settings make use of resources to mediate and manage dilemmas in practice?* To answer this question the individual resource conceptualizations served as a guide to link what the RSMTs were using to mediate the dilemmas they experienced. It was important to make this link as it highlights the ways in which resources interact in a network to mediate a variety of dilemmas—resources working together to assist in mediating one dilemmatic situation, while simultaneously working with the same and/or other resources to help in another dilemmatic situation.

Of note are three critical resources that assisted in mediating a variety of the dilemmas the RSMTs experienced—technology, including the internet, other teachers,

and teaching and professional experiences. Though appearing as separate resources, I would like to note that there are examples in the data where the resources intersect, making it difficult to distinguish between the three. An example is how Christa uses mathematics teacher blogs and websites to collaborate with other teachers while thinking about her own teaching experiences and the experiences of the teachers she is interacting with online. By making use of these resources Christa is making sense of her situation in ways that are unique to her individual understanding of the teaching and learning of mathematics while also being open to trying new things.

Finally, though many of the dilemmas the RSMTs are experiencing are being mediated and continue to be worked through, there are some dilemmas that these teachers felt they did not have access to adequate or appropriate resources to carry out what is being expected. An example is how the RSMTs discussed having a lack of confidence in student abilities that influenced how they went about preparing for and implementing instruction, often facing decisions that determine how they go about supporting students' grade-level understanding of content while at the same time being tested on the grade-level content by the state at the end of each course. Judy specifically said that she did not have resources to mediate this dilemma, but tried to rely on the internet, colleagues, and her professional teaching experience to help her make decisions. Other RSMTs also voiced this concern, as the discussed finding it difficult to gain access and awareness of resources that could support reteaching content while also moving forward. Not only do the RSMTs feel like their materials are not appropriate for their students' abilities, but they also talked about how they do not have appropriate materials to implement programs

like RTI and feel that PLC is just another thing to complete rather than a time to grow as a teacher community.

Table 6. Summary of Key Findings for the Research Questions and Sub-questions.

Key Findings	
SQ1: Dilemmas	• For RSMTs, dilemmas that relate to planning and teaching mathematics (ambitious teaching and curriculum materials) stem from (1) viewing the curriculum and assessment expectations to be constantly in flux, (2) believing the curriculum materials provided by their district are not aligned and rigorous enough for the current state curriculum and assessment, and (3) having a lack of confidence in student abilities. • Dilemmas across the RSMTs conceptualizations are aggregated in three categories—the dilemma of ambitious teaching, the dilemma of curriculum materials, the dilemma of control.
SQ2: Resources	• The internet and technology play a significant role in how RSMTs conceptualize resources. • Resources that are provided by the district are often outdated; a result of a state-determined mathematics curriculum which is constantly in flux. • Resources across the RSMTs conceptualizations are aggregated in five categories—school materials, curriculum materials, other teachers, experience, and students.
RQ: Resources as mediators of dilemmas	• The internet, teaching and professional experiences, and other teachers act as primary resources teachers' make use of to mediate the dilemmas the RSMTs experience. • RSMTs consistently discuss a lack of confidence in students' grade-level mathematical abilities but lack the resources to mediate the dilemmas that stem from this lack of confidence. • There are resources intended to support RSMTs actions and decision making; however, they are not always implemented effectively or align with current curriculum expectations.

CHAPTER FIVE

DISCUSSION AND IMPLICATIONS

The purpose of this study was to understand how resources mediate the dilemmas rural secondary mathematics teachers experience. Subsequently, this study also looked at what dilemmas RSMTs experience and how they conceptualize resources. The resulting findings illustrate how a group of five RSMTs conceptualize resources and utilize those resources to mediate the dilemmas they experience in-context-in-practice. The final chapter of this dissertation begins with a discussion that situates this study within educational and mathematics education research and addressing practical and theoretical implications. This chapter ends with recommendations for future research and a conclusion.

Discussion

The purpose of this study was to investigate the mediating relationship resources have on the dilemmas RSMTs experience in-context-in-practice. Not only did this study provide findings that describe conceptualized resources that assist in mediating the dilemmas the teachers experience, the data also indicate the importance of having a nuanced account of resources and dilemmas that draws on the perspective of individual teachers. The situated perspective used to frame this study afforded the opportunity for this to be noticed, in addition to allowing the contextual nature of dilemmas and resources to be described through the participants voice and actions.

Additional insights from the analysis were presented in Chapter 4. These insights illuminated the individual nature of resources and dilemmas in-context-in-practice, while also highlighting categories and resources across the RSMTs. Across the cases, these

insights illuminated several common dilemmas that collated into three categories—the dilemma of ambitious teaching, the dilemma of curriculum materials, and the dilemma of control—and common resources into five categories—school materials, curriculum materials, other teachers, experience, and students. While collating around these initial categories, the findings highlighted significant differences where years of experience appeared to influence the dilemmas and resources teachers made use of in the mediation and decision-making process with respect to dilemmatic situations. The individual resource conceptualizations and dilemma experiences also affected each teacher in different ways, causing them to have to make compromising and often challenging decisions based on a myriad of outside factors and their conceptualized resource network.

At the outset, the intention of this dissertation study was to bring focus to the rural context that provides access to investigating resources and dilemmas and their interactions in-context-in-practice. This was in response to the literature that indicates a, “pragmatic necessity and empirical imperative to understand individuals who teach in these districts” (Burton, Brown, and Johnson, 2013, p. 26), due to the dearth of educational research about the rural experience (Brown & Johnson, 2010; Burton, Brown, & Johnson, 2013) and the individual nature of rural communities that represent diverse groups of individuals who have little in common except their classification as being *rural* (Burton, Brown, & Johnson, 2013; Howley & Gunn, 2003; Sher, 1977). This study adds to the literature on the rural experience teaching and learning mathematics and supports the individualized nature of the rural experience by furthering the notion past individualized rural experiences at the community level to that of the individuals which constitute the population.

Additionally, this dissertation study shifts our orientation towards the contextual and institutionalized rural setting (Howley & Gunn, 2003), where contradictions and commonalities are discovered that converge and diverge from the modest literature base that does exist on the rural experience. For instance, earlier reports indicate that rural mathematics teachers are professionally isolated and distant from resources, inflexible and resistant to change, and lacking knowledge and credentials (Burton, Brown, & Johnson, 2013). In contrast, this study shows a collection of RSMTs who, while being geographically isolated, are able to connect with other teachers in their school, community, and the internet—masking a sense of professional isolation. While not necessarily finding a feedback loop that would be evident when working with teachers in the school or community, the RSMTs used the internet in ways that gave them access to the curriculum materials, experiences, reflections, and thoughts about mathematics teaching and learning of other teachers. The RSMTs were also cognizant of change occurring outside of their control and consistently found ways to change to improve student understanding and achievement with the current state curriculum and based on their understanding of the curricular expectations. This is in contrast to a picture being painted of rural mathematics teachers as resistant or inflexible to change (Burton, Brown, & Johnson, 2013); rather, the RSMTs in this context describe wanting to change but not having the appropriate support and materials that would help guide their professional metamorphosis.

This study also fluctuates in its divergence and convergence with literature that claims rural schools are limited on resources (Stern, 1994). In large part, this is due to the fact that RSMTs have adapted their work to their contextual boundaries and the

advancement of digital technologies have afforded teachers the opportunity to expand their resource networks beyond their localized context. The RSMTs did not have the same material resources (e.g., instructional technologies) and human resources (e.g., professional learning opportunities, instructional coaches) as their urban and suburban counterparts (Panizzon, 2015; Roberts, 2005; Sundeen & Sundeen, 2013). For example, Sarah had just received a document camera to use in her classroom, Kate wanted to have access to a 3-D printer to use with her classes, other teachers wanted to have one-to-one technologies with students, and the district does not have a system-wide mathematics supervisor or instructional coaches dedicated to secondary mathematics educators—each of which has the potential to be found within the context of their urban and suburban counterparts. Thus, it is evident that this study highlights the issues surrounding a lack of funding that is brought up in literature about rural settings and schools (Harmon, Gordanier, Henry, & George, 2007). A lack of funding could be a factor that impacts the access to material and human resources and causes the RSMTs to seek out a different set of resources than teachers in other educational settings.

Another point that appeared throughout the data was a frustration with a set of state curriculum and assessment practices that are consistently changing. Judy discussed having been part of a group of teachers, from across her state, who gathered to search the internet to find relevant activities and materials for each of the mathematics curriculum standards at that time. She described spending weeks being part of this project and tenuous hours spent searching, discussing, and matching a collection of activities to standards. This collection of internet-based resources was then aggregated and placed on the state website for teachers across the state to use. Judy went on to describe how

valuable this resource was and how she trusted what was linked to the standards because actual mathematics teachers, from her state, had spent time unpacking the standard and finding relevant resources that could be adapted and used in the classroom. This resource had saved Judy time when planning that allowed her to focus on other changes she needed to make in her practice, but, as the state made changes to the curriculum again, the site disappeared and was out of service. She said there is nothing that was ever close to replacing what was there and is an added reason she feels she has to reinvent rather than tweak and improve year-to-year. This site is not exactly what Panizzon (2015) is intending to be accessible for teachers in remote areas, where Panizzon wants more interactive features and professional learning to be available, but it was a start to connecting teachers across the state with a common resource.

From the findings, it is apparent that each individual RSMT, and the collective, make use of a flexible network of resources to mediate the dilemmas they experience. However, one large point of divergence from previously discussed literature is how few participants conceptualized their students, discourse practices, classroom community, and culture as a resource to mediate the dilemmas they experienced (e.g., Civil, 2007; Turner et al., 2016). This places the RSMTs in a different form of isolation that disconnects some of their professional actions and decisions from the cultural and classroom context. Christa and Kate seem to be the most aligned with this conceptualization of resources and it helps mediate some of the dilemmas they experience, but viewing culture, community, discourse, and students as a resource could aid mediating the dilemma of engaging students Donald describes, the dilemma of supporting students grade-level understanding Judy describes, and the dilemma of ambitious teaching described by Sarah.

Additionally, as resource networks become a more popular area of inquiry in mathematics education, the distinguishing factor between this study and those exploring similar domains, is that resources are not typically discussed in a way that links to decision making and actions that are a result of the actual enactment of teaching. This gets to the ideas like *lived resources* (Gueudet, Pepin, & Trouche, 2009) and teachers use of resources as *re-sourcing* (Adler, 2000), where the perspective aligned with the teacher's interpretation and adaptation of resources. This study furthers these ideas and begins to flip the focus of resources to the periphery and brings back in to focus the actions and decision-making of teachers on a day-to-day basis.

This focus does not highlight the researchers understanding of what resources are available to the teacher, but rather how the teacher conceptualizes resources and makes decisions based on the resources of which they interact. The internet, teaching and professional experiences, and other teachers were conceptualized resources that act as primary resources the RSMTs make use of to mediate the dilemmas they experience. But it is only by understanding the rural teaching experience that how and why these resources are sought out and used made sense.

It was interesting to uncover what the RSMTs discussed as dilemmas and resources, but it was also just as interesting what was not discussed. In the educational research about curriculum, some scholars use the term *null curriculum* to shed light on critical educational issues and describe what is not being taught in schools (Eisner, 1985; Flinders, Noddings, Thornton, 1995). Though described as undefinable, with the fear of becoming trivial, the term is useful in an operational sense to talk about educational issues (Flinders, Noddings, Thornton, 1995). For this study, the terms *null resources* and

null dilemmas are used to describe what is not being used and experienced by the RSMTs.

For this study, *null resources* include aspects of culture, community, students, class textbooks, and professional development as pertinent examples. The idea of culture, community and students as a resource idea was first connected through the concept of students' funds of knowledge by Moll and colleagues (Moll et al., 1992). This work was continued by the likes of Civil in mathematics education (e.g., Civil 2007) and furthered in mathematics education by Turner and colleagues (Turner et al., 2016). Each of which instance supported teacher's understanding of students that afforded greater opportunities for students to engage and make sense of mathematics on a personal level. Another *null resource* is an up to date course textbook, and even enough textbooks for each classroom to have a set, a mainstay in many mathematics classrooms that when absent places (Ball, 2012). a missing resource that causes RSMTs to rely on their intuition, experience, other teachers, and the internet to know what should and shouldn't be taught with regards to the current state standards.

Additionally, *null dilemmas* are observed in that much of the literature describes dilemmas that were not captured by the experiences described by the participants. For example, dilemmas surrounding classroom discourse seemed absent from the experiences of these teachers, but numerous in the literature with examples like the dilemma of revoicing (Herbel-Eisenmann, Drake, & Cirillo, 2009) and the dilemma of telling (Baxter & Williams, 2010). This is not to fault these teachers for not describing these dilemmas, but rather that they are not being given the opportunity to reflect on their practice with other teachers in a way that allows them to think about their actions and decisions in light

of possible alternatives. A resource that is intended to afford these opportunities is meeting in professional learning communities, but as the RSMTs in this study described, PLC is not implemented in a way that makes it useful.

Overall, this study shows us the nuanced resource networks teachers make use of to mediate the dilemmas they experience and felt comfortable working as a teaching professional. Viewing these networks and experiences from the individual's perspective proved to be critical in understanding the rural teaching experience and noticing differences in how RSMTs act and make decisions. As mentioned at the start of this dissertation, teaching is a complex and intellectual endeavor, and this study shows that understanding teachers as dilemma managers proves to be a complex and intellectual endeavor that must account for the situated and individual nature and experience of mathematics teaching and learning.

Theoretical and Practical Implications

This dissertation provided a nuanced look at five RSMTs conceptualization of resources and the mediating relationship these resources have with the dilemmas they experience. Considerations for theoretical and practical connections to the dissertation study are presented in the following sections.

Theoretical implications. There are four ways this study has significance in terms of its contributions to educational theory. The first is that it provides a view of resources for the teaching and learning of mathematics that is often neglected in the literature, the teacher's perspective. Those working in educational research often have a view of resources that is dependent on their experiences, dispositions, orientations and with education. By removing the researcher from the equation and drawing on situated

perspective, with qualitative case study as the methodological tradition, a more contextual, localized, and individualized understanding of resources placed its understanding in-context-in-practice. In doing so it was observed that resources that are often left in separate traditions merged in the RSMTs conceptualizations and worked together in a network to mediate the dilemmas they experienced. For instance, Sarah's perspective on resources included dispositions, experiential knowledge, relationships, and school mathematics materials. Separately, these resources would be considered to fall in theoretical domains like identity and material resources, but for Sarah they were just resources that she made use in her actions as a dilemma manager. Thus, in understanding Sarah's actions and decisions in-context-in-practice required a more integrated view of resources that bridges together often divergent theoretical domains and expands notions of resources for the teaching and learning of mathematics. Additionally, Christa and Kate's conceptualization and use of the student experience as a resource, by way of uncovering students' attitudes and beliefs, is another instance where the common notion of what constitutes a resource is debunked, and student identity emerges as a relevant resource these teachers are conceptualizing and using in-context-in-practice. This begins to envelop some relevant work in the field today around resources that build one's identity (Hand & Gresalfi, 2015; Nasir & Cooks, 2009), and continues to expand our notion of resources for the teaching and learning of mathematics that was shared by Adler (2000) to begin thinking about identity as a resource that can be both built and used.

Second, while many studies explore the dilemmatic situations that teachers experience, this study shifts the focus from the dilemma itself to the management of such dilemmas. Furthering the inquiry to not to shape a narrative that describes teacher's

experience with dilemmas through a deficit lens, but rather recognizing that dilemmas in teaching are inherent and viewing the teacher as a competent dilemma manager on the front end. Framing the understanding of teacher's work as a dilemma manager (Lampert, 1985) proved to be an important feature of this dissertation and afforded the opportunity to explore the mediating role resources in-context-in-practice and showed progress in making connections between dilemmas and resources that has the potential to build a theory around the mediating relationship resources have on dilemmas.

A third theoretical contribution this study makes is that it supports a starting point towards identifying a teachers' learning trajectory with resources. This is not a novel idea. Instead, this idea stems from work around technology resources, technology knowledge (TK), and technological pedagogical content knowledge (TPACK; Koehler, Mishra, & Cain, 2013) in education. While technology is an important resource in today's society, it is but one of many resources that, when used appropriately, enhances the teaching and learning that occurs in the classroom. Viewing technology as one of many resources has the potential to merge that body of literature with other conceptions of resources (e.g., identity, classroom discourse, and culture). Shifting TK to become *resource knowledge* (i.e., RK—a deep understanding of available material and immaterial resources to accomplish a variety of goals and tasks) and TPACK to become *resource pedagogical content knowledge* (i.e., RPACK—the basis of effective mathematics teaching with material and immaterial resources and requires an understanding of effective integration of resources with teacher decision-making) (Lawson & Hodge, 2019). In doing so, RPACK can expand the application of TPACK research and make use of the TPACK developmental framework (Figure 7; Niess et al., 2009) to begin

conceptualizing teachers use of resources in-context-in-practice and along a trajectory. Table 7 takes this developmental model and explains the minute shift to include resources as the overarching knowledge domain.

The RPACK developmental model (Table 7) provides a framework to understand how teachers are progressing towards resource integration. This is particularly relevant as the findings indicate many of the RSMTs are across the trajectory with respect to a variety of resources. For instance, Donald is still recognizing and accepting the textbook as a resource to use in the classroom, Judy's use of PowerPoint indicates her advancing her use of the program, and Christa is findings ways to adapt formative assessment techniques in the classroom. Additionally, this study indicates a potential for a connection to be made between the levels of development and the role of a resource in the dilemma mediation process, placing different resources as more or less significant based on the teacher's progression along the trajectory with respect to using a resource in-context-in-practice.

Finally, there exist deficit storylines in the limited literature on rural education. This draws attention to rural teachers as the problem and gives voice to the notion of *place as obstacle* or *place as deficit* (Burton, Brown, & Johnson, 2013). This study combats that notion by giving voice to the RSMTs who not once viewed their place as deficit or an obstacle. Instead, the RSMTs describe their place as just another location to teach. The teachers show instances of holding a deficit view of student's mathematical abilities, but that was not in the context of place, rather the educational system as a whole.

Table 7. Five-stage developmental Cycle for Technology and Resource Integration.

Developmental Step	TPACK (Niess et al., 2009, p. 9)	RPACK
Recognizing	Teachers are able to use the technology and recognize the alignment of the technology with mathematics content yet do not integrate the technology in teaching and learning of mathematics.	Teachers are able to use resources and recognize the alignment of the resources with mathematics content yet do not integrate resources in teaching and learning of mathematics.
Accepting	Teachers form a favorable or unfavorable attitude toward teaching and learning mathematics with an appropriate technology.	Teachers form a favorable or unfavorable attitude towards teaching and learning mathematics with appropriate resources.
Adapting	Teachers engage in activities that lead to a choice to adopt or reject teaching and learning mathematics with an appropriate technology.	Teachers engage in activities that lead to a choice to adopt or reject teaching and learning mathematics with appropriate resources.
Exploring	Teachers actively integrate teaching and learning of mathematics with an appropriate technology.	Teachers actively integrate teaching and learning of mathematics with appropriate resources.
Advancing	Teachers evaluate the results of the decision to integrate teaching and learning mathematics with an appropriate technology.	Teachers evaluate the results of the decision to integrate teaching and learning mathematics with appropriate resources.

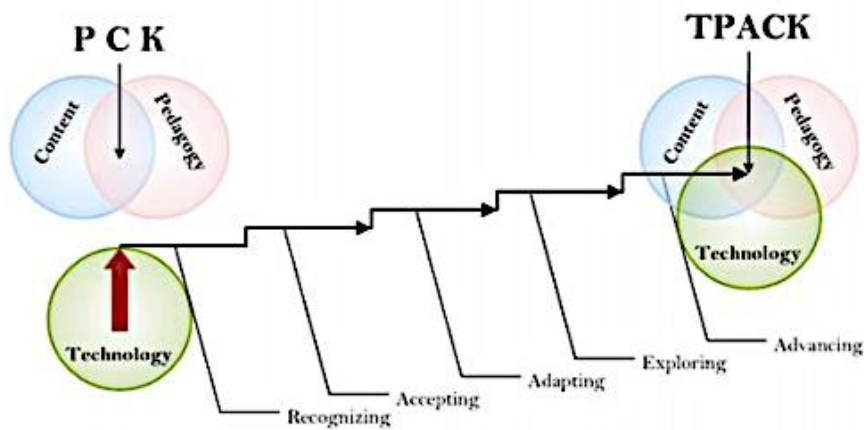


Figure 7. TPACK development model (Niess et al., 2009).

Practical implications. There are some practical implications that are a product of this study. First, the study provides a better understanding of dilemmas and resources that should be used to inform the future design of teacher education, curriculum resources, and professional development opportunities for RSMTs in this context. Teacher educators can begin thinking about how teacher candidates come to understand resources and find activities and ways to develop their resource conceptualization and its potential to help them manage the dilemmatic situations they will experience. Curriculum resources, such as educative curriculum materials (Ball & Cohen, 1995; Davis & Krajcik, 2005; Hill & Ball, 2009), should also continue this work by linking potentially relevant resources with activities that are being provided and post-lesson reflective questions that relate to dilemma management and improvement of their actions and decision-making. In addition, this study can provide a framing to engage professional development participants in discussions that draw on their localized conceptualizations and experiences, or *teachers' funds of knowledge*, to support teachers'

their capacity to interpret and internalize professional development goals and enact high-quality and ambitious instruction in-context-in-practice.

Second, this study indicates the need for more opportunities for teachers to collaborate and reflect. As this study and others have shown, teaching can be geographically and professionally isolating (Erlandson, 1994; Panizzon, 2015). It was noted that PLC is one instance where the local school district is trying to support collaboration between teachers, but the RSMTs characterization of what happens in a PLC meeting makes the process not effective to meet the goals and needs of the teachers participating. Thus, schools and school leaders need to better facilitate collaboration within and between departments, whether through PLC or another approach. Looking beyond their local environment, the RSMTs found digital environments on the internet to be an avenue to collaborate, engage, and reflect in a professional network of mathematics teachers. The RSMTs here indicated using online spaces to grow professionally and the idea is catching on in the field where teachers are forming networks through social media platforms (Carpenter & Krutka, 2014). An existing example is how teachers are going about using Twitter. The hashtags #MTBoS (i.e., mathematics twitter blog-o-sphere) and #iteachmath are used by mathematics educators to share experiences and receive feedback from other mathematics educators, educational researchers, and policy makers, to name a few.

Third, teacher education and teacher educators should expand what is considered to be a resource and embrace these digital professional networks. By embracing these networks, teacher educators can support and guide aspiring teachers' engagement with them. This can be accomplished by positioning what is happening in these online

networks as a blend of theory and practice, where teacher candidates reflect on others practice and materials by way of reflection and evaluation. As the concept of an online professional learning network continues to expand in education (e.g., Carpenter & Krutka, 2014) and has become a reality for many current teachers, teacher educators must think about how their curriculum prepares teachers to engage collaboratively in this way.

A fourth implication is that there needs to be more funding for rural schools and communities to have high-quality professional development and access to grants that would support RSMTs practice, actions, and decision-making. The Tennessee STEM Innovation Network (TSIN) is an example from Tennessee, where an initiative is taking place that is intent on providing funding, professional development, grants, and, overall, access to rural communities across the state to improve STEM education. Subsequently each part of the state (east, middle, west) have STEM Hub's that provide regional support.

A fifth practical implication is the need to support teachers and manage our (e.g., researchers, policy makers, school board members, citizens) expectations for how teachers are going to adjust to changing standards and assessments. While having a policy slant, this implication is intended to This should be reflected in the materials that are provided by the district, evaluation criteria, and students that are a by-product of the change. In addition, a w

Recommendations for Future Research

There are four recommendations for future research that stem from this dissertation study. First, though this study focuses on RSMTs individually and as a whole, it may be important for a follow-up study or analysis to consider clusters of

teachers based on years of experience, among other factors, as this was a factor that was found to highlight significant differences between the RSMTs who participated in this study. As the years proved to be a differentiator for dilemmas and resources, so to might end of course student assessment data, teacher evaluation data, or one's teacher preparation program. This could help to better understand how groups of RSMTs, and teachers in general, conceptualize resources and experience and mediate dilemmas.

A second recommendation is to explore teachers resource enactment by making use of the TPACK developmental model (Niess et al., 2009) within an RPACK framework (Lawson & Hodge, 2019). This would best be accomplished if explored across years of experience and context, as indicated as a potential differentiator for resources and dilemmas in this study. Having vignettes and studies on this idea would be useful in understanding resources use and integration into practice and how this use and integration varies across experience and context, allowing the field to look within and across experience for how resource knowledge plays out and integrates with teachers' pedagogical content knowledge. This would have implications for research about supporting teacher knowledge and learning and the structure for educative curriculum materials and how they are to be used by the teacher.

Third, the advancement of technologies and the nature of working as a teacher in the digital age has changed how teachers work. The wide use of the internet by the RSMTs in this study show a need to further understand how teachers interact with, make sense of, and integrate in their practice the variety of online blogs, microblogs, lesson plan aggregates, teacher websites, and professional organizations, to name a few. Not only understanding the internet and technologies as a resource but understanding what

happens when a teacher engages with these technologies and how the resource is brought back and shared with a localized community. Additionally, how do these internet-based resources further highlight dilemmas and challenges that teachers may not even be aware that they are experiencing.

Fourth, the role of student and teacher data, school-based teacher leaders (e.g., department chair, instructional coach), and administrators or district leaders was largely absent from much of this study. It is unclear if the data collection materials were just not designed to capture these aspects or not, but with the plethora of research around how teachers use data and teacher/administrator leadership may have just fallen into a similar gap that much research around a rural context falls into—it's scarce.

The final recommendation is to focus more of our research on teacher decision making. As teaching is a complex practice, it is important that our research does not become too disjoint from the realities of practice. A focus on teacher decision making blends theory and practice to both serve our theoretical objectives while also making sure to contribute to the practical realities of the teachers (and students) of whom we are studying and of which we are trying to improve the lives. Understanding the role of resources in these decisions also has the potential to be a direction for inquiry opens the door to better curriculum material development and teacher education.

Conclusion

In our first interview session, Judy stopped at one point and said, "I love these kids. If I didn't, I would've left a long time ago. The pay is crap, but *we have potential here.*" The phrase "*we have potential here*" stayed with me throughout the study. "*We have potential here.*" Judy wanted me to know that this is a community that might not

have the best state assessment or ACT scores and has some issues within the community itself, but when she looks at her school and students, she sees *potential*.

The deficit narrative around rural education and schools can be toxic for those working in the schools and communities. At some point or another, each participant spoke to what it is like teaching in a place that is viewed as less, it was apparent that being asked to be part of a dissertation study was not something that was common in that area. I would constantly be asked by the participants if they were answering my questions during the interview and they wanted extra time to put thought into their resource diary entries—“there’s no wrong answer,” I would respond—and it was noticeable that some felt uncomfortable at times when I was conducting an interview—“I’m here to understand, not judge,” I would tell them. This encapsulates my main learning about conducting research through this dissertation process. It is important to listen, be open, and have respect for the people who are agreeing to share parts of themselves for the purposes of research. In reflection, the activity of conducting qualitative research is similar to the work of being a mathematics teacher. In both roles you have an objective or overarching question, you are listening to uncover another’s thinking about a topic or concept, and you have an idea of how people will respond but are always amazed at how wrong or narrow your initial thinking was before you engaged with another.

The idea of dilemmas and interpreting the activity of the teacher as dilemma manager has shifted how I approach working with pre-service teachers in university courses and engage with practicing teachers in the field or professional development settings. I now find myself encouraging teachers to engage in discussions about the

nuances and complexities that exist in the realities of classroom, and the term, “dilemma,” becomes a part of our shared vernacular that gives voice to everyone as we all can share experiences and ideas to be used to help work through challenging situations. Even after this dissertation study, there is still much to be learned about the nature, role, and use of resources for the teaching and learning of mathematics, and teachers deserve to be supported in findings ways to mediate the dilemmas that they experience.

In closing, I would like to encourage all researchers to drive to geographically remote communities, conduct research and professional developments in these communities, understand the teachers and immerse yourself in the lives and culture of those within the community. Understudied communities, like the rural community that acted as the site for this study, deserve to be heard as they too have thoughts about the teaching and learning of mathematics.

LIST OF REFERENCES

- Adler, J. (1995). Dilemmas and a paradox: Secondary mathematics teachers' knowledge of their teaching in multilingual classrooms. *Teaching and Teacher Education*, 11(3), 263-274.
- Adler, J. (1998a). Resources as a verb: Reconceptualising resources in and for school mathematics. *Proceedings of the Conference of the International Group for the Psychology of Mathematics Education*. Stellenbosch, South Africa.
- Adler, J. (1998b). A language of teaching dilemmas: Unlocking the complex multilingual secondary mathematics classroom. *For the Learning of Mathematics*, 18(1), 24-33.
- Adler, J. (1999). The dilemma of transparency: Seeing and seeing through talk in the mathematics classroom. *Journal for Research in Mathematics Education*, 30(1), 47-64.
- Adler, J. (2000). Conceptualizing resources as a theme for teacher education. *Journal of Mathematics Teacher Education*, 3(3), 205-224.
- Arnold, M. L., Newman, J. H., Gaddy, B. B., & Dean, C. B. (2005). A look at the condition of rural education research: Setting a direction for future research. *Journal of Research in Rural Education*, 20(6), 1-25.
- Ball, D. (1993). With an eye on the mathematical horizon: Dilemmas of teaching elementary school mathematics. *The Elementary School Journal*, 93(4), 373-397.
- Ball, D., & Cohen, D. (1995). Reform by the book: What is—or might be—the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher*, 25(9), 6-8, 14.

- Ball, D., Lubienski, S., & Mewborn, D. (2001). Research on teaching mathematics: The unsolved problem of teachers' mathematical knowledge. In Richardson, V. (Ed.) *Handbook of Research on Teaching* (4th ed.). New York: Macmillan.
- Ball, D. L. and Bass, H. (2003) Making mathematics reasonable in school. In J. Kilpatrick, W. G. Martin and D. E. Schifter (Eds.), *A Research Companion to Principles and Standards for School Mathematics* (p. 27–44). Reston, VA: National Council of Teachers of Mathematics.
- Ball, D., Thames, M., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5), 389-407.
- Ball, D. (2012). Afterword: Using and designing resources for practice. In G. Ghislaine, B. Pepin, & L. Trouche (Eds.) *From text to lived resources: Mathematics curriculum materials and teacher development* (p. 349-352). London: Springer.
- Bartell, T. G., Drake, C., Roth McDuffie, A., Foote, M. Q., Aguirre, J., & Turner, E. E. (2015). Mathematics Classroom Practice Module. In C. Drake et al. (Eds.), *TeachMath Learning Modules for K-8 Mathematics Methods Courses*. Teachers Empowered to Advance Change in Mathematics Project. Retrieved from: <http://www.teachmath.info/modules/classroom-practices-module/>
- Bates, A. (2014). Recognizing the intellectual complexity of teaching. *Democracy & Education*, 22(2), 1-5.
- Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, 13(4), 544-559.

- Baxter, J., & Williams, S. (2010). Social and analytic scaffolding in middle school mathematics: Managing the dilemma of telling. *Journal of Mathematics Teacher Education*, 13(1), 7-26.
- Boaler, J. (2002). *Experiencing school mathematics: Traditional and reform approaches to teaching and their impact on student learning, revised and expanded edition*. New York: Routledge.
- Borko, H., Stecher, B., Alonzo, A., Moncure, S., & McClam, S. (2005). Artifact packages for characterizing classroom practice: A pilot study. *Educational Assessment*, 10(2), 73-104.
- Borko, H., Stecher, B., Martinez, F., Kuffner, K., Barnes, D., Arnold, S., Spencer, J., Creighton, L., & Gilbert, M. (2006). *Using classroom artifacts to measure instructional practice in middle school science: A two-state field test*. Los Angeles: National Center for Research on Evaluation, Standards, and Student Testing.
- Bradshaw, R. (2014). Democratic teaching: An incomplete job description. *Democracy & Education*, 22(2), 1-5.
- Brodie, K. (2010). Pressing dilemmas: Meaning making and justification in mathematics teaching. *Journal of Curriculum Studies*, 42(1), 27-50.
- Broudy, H. (1956). Teaching—craft or profession? *The Educational Forum*, 20(2), 175-184.
- Brown, J., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32-42.

- Burton, M., & Johnson, A. (2010). 'Where else would we teach?': Portraits of two teachers in the rural south. *Journal of Teacher Education*, 61(4), 376-386.
- Burton, M., Brown, K., & Johnson, A. (2013). Storylines about rural teachers in the United States: A narrative analysis of the literature. *Journal of Research in Rural Education*, 28(12), 1-18.
- Byers, B. (1984). Dilemmas in teaching and learning mathematics. *For the Learning of Mathematics*, 4(1), 35-39.
- Byun, S., Meece, J., & Irvin, M. (2012). Rural-nonrural disparities in postsecondary educational attainment revisited. *American Educational Research Journal*, 49(3), 412-437.
- Carpenter, J., & Krutka, D. (2014). How and why educators use twitter: A survey of the field. *Journal of Research on Technology in Education*, 46(4), 414-434.
- Civil, M. (2007). Building on community knowledge: An avenue to equity in mathematics education. In Nassir, N. & Cobb, P. (Eds.), *Improving access to Mathematics: Diversity and Equity in the Classroom* (p. 105-117). New York: Teachers College Press.
- Clandinin, D., & Connelly, F. (1996). Teachers' professional knowledge landscapes: Teacher stories—stories of teachers—school stories—stories of schools. *Educational Researcher*, 25(3), 24-30.
- Clark, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education*, 18(8), 947-967.
- Cobb, P., & Bowers, J. (1998). Cognitive and situated learning perspectives in theory and practice. *Educational Researcher*, 28(2), 4-15.

- Corbett, M. (2007). *Learning to leave: The irony of schooling in a coastal community*. Peterborough, Ontario: Fernwood.
- Creswell, J., & Poth, C. (2018). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches* (4th ed.). Thousand Oaks, CA: Sage.
- Davis, E., & Krajcik, J. (2005). Designing educative curriculum materials to promote teacher learning. *Educational Researcher*, 34(3), 3-14.
- Davis, E., Palincsar, A., Smith, P., Arias, A., Kademian, S. (2017). Educative curriculum materials: Uptake, impact, and implications for research and design. *Educational Researcher*, 46(6), 293-304.
- Drake, C., Spillane, J., & Hufferd-Ackles, K. (2001). Storied identities: Teacher learning and subject-matter context. *Journal of Curriculum Studies*, 33(1), 1–23.
- Duncan, C. (2006, January 9). *Why poverty persists in Appalachia: An interview with Cynthia M. Duncan*. Retrieved from:
<https://www.pbs.org/wgbh/pages/frontline/countryboys/readings/duncan.html>
- Eisner, E. (1985). *The educational imagination: On the design and evaluation of school programs* (2nd ed.). New York: Macmillan Publishing.
- Fisler, J. L., & Firestone, W. A. (2006). Teacher learning in a school-university partnership: Exploring the role of social trust and teaching efficacy beliefs. *Teachers College Record*, 108(6), 1155–1185.
- Flick, U. (2014). *An introduction to qualitative research* (5th ed.). London: SAGE.
- Flinders, D., Noddings, N., & Thornton, S. (1986). The null curriculum: Its theoretical basis and practical implications. *Curriculum Inquiry*, 16(1), 33-42.

- Greeno, J. (1997). On claims that answer the wrong questions. *Educational Researcher*, 26(1), 5-17.
- Ghislaine, G., Pepin, B., & Trouche, L. (Eds.). (2012). *From text to lived resources: Mathematics curriculum materials and teacher development*. London: Springer.
- Goldsmith, L., Doerr, H., & Lewis, C. (2014). Mathematics teachers' learning: A conceptual framework and synthesis of research. *Journal of Mathematics Teacher Education*, 17(1), 5-36.
- Hand, V., & Gresalfi, M. (2015). The joint accomplishment of identity. *Educational Psychologist*, 50(3), 190-203.
- Harmon, H., Gordanier, J., Henry, L., & George, A. (2007). Changing teaching practices in rural schools. *The Rural Educator*, 28(2), 8-12.
- Herbel-Eisenmann, B., Drake, C., & Cirillo, M. (2009). Muddying the clear waters: Teacher's take-up of the linguistic idea of revoicing. *Teaching and Teacher Education*, 25(2), 268-277.
- Hill, H., Ball, D., & Schilling, S. (2008). Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic-specific knowledge of students. *Journal for Research in Mathematics Education*, 39(4), 372-400.
- Hill, H., & Ball, D. (2009). The curious—and crucial—case of mathematical knowledge for teaching. *Phi Delta Kappan*, 91(2), 68-71.
- Hodge, L., Cheng, K., King, S., & Kim, N. (2018). Elementary teachers' take-aways from summer math Institutes in a three-year professional development project in rural Appalachia. *Proceedings of the 42nd annual meeting of the International*

- Group for the Psychology of Mathematics Education* (p. 250). Umea, Sweden: The University of Umea.
- Horn, I. S. (2005). Learning on the job: A situated account of teacher learning in high school mathematics departments. *Cognition and Instruction*, 23(2), 207–236.
- Horn, I., & Little, J. (2010). Attending to problems of practice: Routines and resources for professional learning in teachers' workplace interactions. *American Educational Research Journal*, 47(1), 181-217.
- Howley, C., & Gunn, E. (2003). Research about mathematics achievement in the rural circumstance. *Journal of Research in Rural Education*, 18(2), 86-95.
- Howley, C., Larson, W., Andrianaivo, S., Rhodes, M., & Howley, M. (2007). Standards-based reform of mathematics education in rural high schools. *Journal of Research in Rural Education*, 22(2), 1-12.
- Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding It Up: Helping Children Learn Mathematics*. Washington, DC: National Academy Press.
- Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, 9(1). Retrieved from <https://www.citejournal.org/volume-9/issue-1-09/general/what-is-technological-pedagogicalcontent-knowledge>
- Koehler, M., Mishra, P., & Cain, W. (2013). What is technological pedagogical content knowledge (TPACK)? *Journal of Education*, 193(3), 13-19.
- Lampert, M. (1985). How do teachers manage to teach? Perspectives on problems in practice. *Harvard Educational Review*, 55(2), 178-194.

- Lampert, M. (1986). Teachers' strategies for understanding and managing classroom dilemmas. In Ben-Peretz, M., Bromme, R. & Halkes, R. (Eds.), *Advances in research on teacher thinking* (pp. 70-83). Lisse, the Netherlands: Swets & Zeitlinge.
- Lampert, M. (1990). When the problem is not the question and the solution is not the answer: Mathematical knowing and teaching. *American Educational Research Journal*, 27(1), 29-63.
- Lampert, M. (2001). *Teaching Problems and the Problems of Teaching*. Yale University Press: New Haven, CT.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, England: Cambridge University Press.
- Lawson, M., & Hodge, L. (2019). Reimagining teacher knowledge: Resource knowledge and its implications. In M. Graven, H. Venkat, A. Essien, & P. Vale, (Eds), *Proceedings of the 43rd Conference of the International Group for the Psychology of Mathematics Education, Vol 4* (p. 61). Pretoria, South Africa: PME.
- Little, J. (2003). Inside teacher community: Representations of classroom practice. *Teachers College Record*, 105(6), 913-945.
- Ma, L. (1999). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States*. Mahwah, N.J: Lawrence Erlbaum Associates.
- Malhoit, G. (2005). Providing rural students with a high quality education: The rural perspective on the concept of educational adequacy. *Rural School and Community*

Trust.

- Merriam, S. (2009). *Qualitative Research: A Guide to Design and Implementation*. San Francisco, CA: Wiley.
- Moll, L., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory into Practice*, 31(2), 132-141.
- Nasir, N. I. S., & Cooks, J. (2009). Becoming a hurdler: How learning settings afford identities. *Anthropology & Education Quarterly*, 40(1), 41-61.
- National Council of Teachers of Mathematics. (1989). *Curriculum and Evaluation Standards for School Mathematics*. NCTM, Reston, VA.
- National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics*. NCTM, Reston, VA.
- National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all*. NCTM, Reston, VA.
- Niess, M., Ronau, R., Shafer, K., Driskell, S., Harper S., Johnston, C., Browning, C., Özgün-Koca, S., & Kersaint, G. (2009). Mathematics teacher TPACK standards and development model. *Contemporary Issues in Technology and Teacher Education*, 9(1), 4-24.
- Panizzon, D. (2015). Impact of geographical location on student achievement: Unpacking the complexity of diversity. In Barkatsas, T., Bishop, A., & Tan, H. (Eds.), *Diversity in mathematics education: Towards inclusive practices* (p. 41-61). New York: Springer
- Patton, M. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand

Oaks, CA: Sage.

- Pepin, B., Gueudet, G., & Trouche, L. (2013). Re-sourcing teachers' work and interactions: A collective perspective on resources, their use and transformation. *ZDM Mathematics Education*, 45(7), 929-943.
- Putnam, R., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher*, 29(1), 4-15.
- Remillard, J., & Bryans, M. (2004). Teachers' orientations toward mathematics curriculum materials: Implications for teacher learning. *Journal for Research in Mathematics Education*, 35(5), 352-388.
- Remillard, J., & Heck, D. (2014). Conceptualizing the curriculum enactment process in mathematics education. *ZDM Mathematics Education*, 46(5), 705-718.
- Roberts, P. (2005). *Staffing an empty school house: Attracting and retaining teachers in rural, remote, and isolated communities*. Australia: NSW Teachers Federation
- Rossmann, G., & Rallis, S. (2012). *Learning in the field: An introduction to qualitative research* (3rd ed.). Thousand Oaks, CA: Sage.
- Rubin, H., & Rubin, I. (2012). *Qualitative Interviewing: The Art of Hearing Data* (3rd ed.). Thousand Oaks, CA: Sage.
- Saldaña, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). London, UK: Sage Publications, Ltd.
- Sandoval-Taylor, P. (2005) Home is where the heart is: A funds of knowledge-based curriculum module. In Gonzalez, N., Moll, L., & Amanti, C. (Eds.) *Funds of Knowledge: Theorizing Practice in Households, Communities, and Classrooms* (p. 153-166). New York: Routledge.

- Sher, J. P. (Ed.). (1977). *Education in rural America: a reassessment of conventional wisdom*. Boulder, CO: Westview Press.
- Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4-14.
- Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.
- Stein, M., & Kaufman, J. (2010). Selecting and supporting the use of mathematics curricula at scale. *American Educational Research Journal*, 47(3), 663-693.
- Stern, J. D. (Ed.). (1994). *The Condition of Education in Rural Schools: Statistical Analysis Report*. Washington DC: US Department of Education, Office of Educational Research and Improvement.
- Sundeen, T., & Sundeen, D. (2013). Instructional technology for rural schools: Access and acquisition. *Rural Special Education Quarterly*, 32(2), 8-14.
- Department of Education (2017). *Report Card*. Nashville, TN. Retrieved from: https://srcreports.measuretn.gov/views/TennesseeSchoolReportcard2017/Profile?:embed=y&:display_count=no.
- Turner, E., Drake, C., Roth-McDuffie, A., Aguirre, J., Bartell, T., & Foote, M. (2012). Promoting equity in mathematics teacher preparation: A framework for advancing teacher learning of children's multiple mathematical knowledge bases. *Journal of Mathematics Teacher Education*, 15, 62-82.
- Turner, E., Foote, M., Stoehr, K., McDuffie, A., Aguirre, J., Bartell, T., & Drake, C. (2016). Learning to leverage children's multiple mathematical knowledge bases in mathematics instruction. *Journal of Urban Mathematics Education*, 9(1), 48-78.

- United States Census Bureau (2016). *QuickFacts*. Washington, DC. Retrieved from:
<https://www.census.gov/quickfacts/fact/table/US/PST045218/>.
- Walker, E. (2006). Urban high school students' academic communities and their effects on mathematics success. *American Educational Research Journal*, 43(1), 41-71.
- White, D., Murray, E., & Brunaud-Vega, V. (2012). Discovering multicultural mathematics dispositions. *Journal of Urban Mathematics Education*, 5(1), 31-43.
- Windschitl, M. (2002). Framing constructivism in practice as the negotiation of dilemmas: An analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. *Review of Educational Research*, 72(2), 131-175.
- Wong, D. (1995). Pluralistic Relativism. *Midwest Studies in Philosophy*, 20(1), 378-399.
- Yin, R. (2014). *Case study research: Design and methods*. Thousand Oaks, CA: SAGE.

APPENDIX

Appendix A: Informed Consent

Informed Consent Statement

INTRODUCTION—What is this study about?

You are invited to participate in a dissertation research study conducted by Michael Lawson, a Ph.D. candidate from the Department of Theory and Practice in Teacher Education at the University of Tennessee, Knoxville. He is conducting research to learn more about how math teachers make use of resources to manage and cope with dilemmas of practice, and how teachers conceptualize resources that most inform and influence their practice. To do this, he is interested in understanding your resource use, experiences, and influences. This information will be helpful in supporting teacher learning through professional development and teacher education; in addition to being helpful in designing and disseminating teacher resources in the future.

INFORMATION ABOUT PARTICIPANTS' INVOLVEMENT IN THE STUDY—What will I ask you to do?

If you give consent to participate, you agree to the following:

- 1) You agree to be observed once during the 2018-2019 school year. The observation will be recorded through hand written field notes, and no audio/visual media will be collected. This is not a “formal observation,” but a time to better understand your resource use in context. A follow up observation can be arranged between the participant and researcher if both parties agree.
- 2) You agree to complete resource diary through Google Forms three times over a two-week period. You will be asked to record resources you make use of and any notes about how they are being utilized to inform your practice.
- 3) You agree to complete two interviews during the 2018-2019 school year. The interviews will take place at your school, but not during instructional time. In addition, at the first interview you will be asked to complete a “Map of Resources” to identify resources most effective in your teaching. The time required to complete each interview will be at most one hour. The interview will be audiotaped. The audio will be stored in the locked office of the researcher at the University of Tennessee. A follow up interview can be arranged between the participant and researcher if both parties agree.

RISKS AND BENEFITS

It is possible that someone could find out you were in this study or see your study information. However, due to the procedures used to minimize this risk, the investigator believes this risk is very low.

There are no anticipated direct immaterial benefits to you resulting from your participation in this study; however, upon completion of your participation you will receive three (3) books related to the teaching and learning of mathematics. These books are intended to support teacher learning.

CONFIDENTIALITY

The information in the study records will be kept confidential. Data will be stored securely and will only be available to myself for review, unless participants specifically give permission in writing to do otherwise. No reference will be made in oral or written reports that could link participants to the study.

CONTACT INFORMATION

If you have questions at any time about the study or the procedures, you may contact the researcher, Michael Lawson, at (865) 441-2398 or mlawso13@vols.utk.edu. If you have questions about your right as a participant, you may contact the University of Tennessee Office of Research Compliance Officer at (865) 974-7697 or utkirb@utk.edu.

PARTICIPATION

Your participation in this project is voluntary; you may decline to participate without penalty. If during the project you decide not to participate, you may withdraw from the study at any time without any penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is complete, your data will be returned to you or destroyed.

CONSENT

I have read the above information. I have received a copy of this form. I agree to participate in this study.

Participant's Name (printed)

Participant's Signature _____ Date _____

Appendix B: Interview #1 Protocol

Interview #1 Protocol

Introduction:

1. Introduction by the researcher.
2. Let's go over the consent form you signed. I want to make sure there are no lingering questions, and I will give you a brief overview of the form.
3. As a reminder, this interview is completely voluntary. If you feel uncomfortable at any time during the interview you may skip any question that causes you discomfort, or you may end the interview.
4. Review with participant the purpose of the interview and explain that this interview will be recorded.
5. Ask the participant: Are you ready to begin recording?

Background Information

1. How many years have you taught?
2. How many years have you taught in this school district?
3. Tell me about what you teach?
4. What matters most in teaching math? Do you have an overarching goal?

Part 1: Resources

1. What helps you when planning or teaching a math lesson?
2. Tell me about any individuals, groups, coursework, professional development, etc. that have an influence on how you teach today?
3. What would help you be the teacher you want to be?

Part 2: Map of Resources

1. *Hand interviewee the Map of Resources, give them time to fill out the document.*
2. Tell me about what you chose.
3. What do you think makes these choices effective?

Part 3: Dilemmas

1. Okay let's step back a little. When planning or teaching, what are the challenges for you? What's problematic?
2. When you encounter a challenge or a problem in planning or teaching mathematics, what do you do?

Closing:

1. Watch the time and do not go over the time allotted.
2. Stop the recorder.
3. Schedule follow-up sessions.
4. Thank the participant for their time.

Appendix C: Interview #2 Protocol

Interview #2 Protocol

Introduction:

1. Introduction by the researcher.
2. Discuss if there were any issues with the resource diary.
3. Remind participant that this interview is completely voluntary. “If you feel uncomfortable at any time during the interview you may skip any question that causes you discomfort, or you may end the interview.”
4. Review with participant the purpose of the interview and explain that this interview will be recorded.
5. Ask the participant: Are you ready to begin recording?

Part 1: Resources

1. Can you tell me about a time when a lesson didn’t go as planned? What happened?
2. When you encounter something that helps you plan or teach a math lesson, can you describe how you make sense of it?
3. We have talked a lot about things you use to plan and teach mathematics. Could you take a moment to describe what makes something effective for you to use when planning or teaching a math lesson? What would make it ineffective?

Part 2: Dilemmas and Resources

1. You mentioned in the last interview that there were some challenges to teaching here.
 - a. Tell me about a challenge you faced in the last couple weeks.
2. When you encounter challenges like this, how do you work through it?
3. Describe a situation (or situations) where you had problems working with a math topic and what you did to address this? What helped? What didn’t help?
4. Describe a situation (or situations) where you had problems working with a student and what you did to address this? What helped? What didn’t help?

Closing:

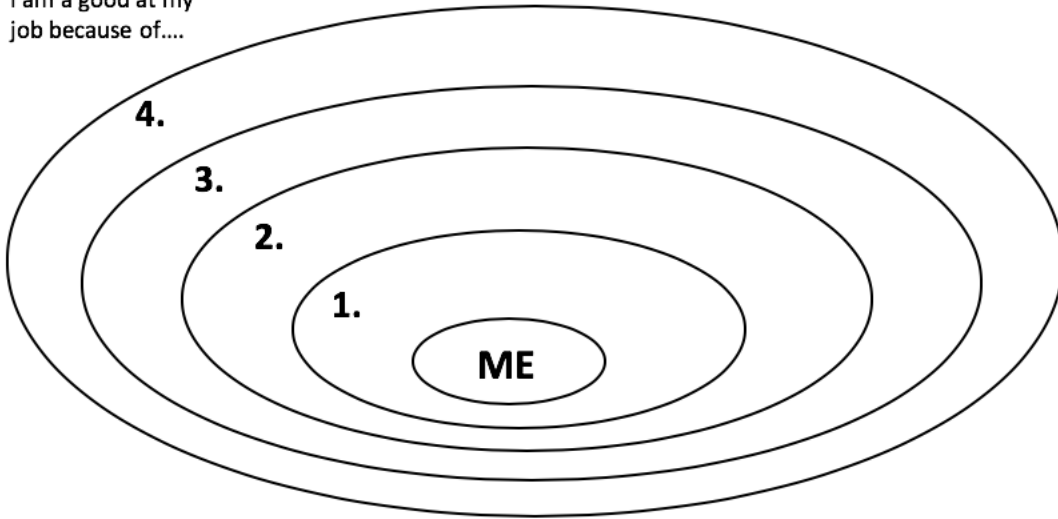
1. Watch the time and do not go over the time allotted.
2. Stop the recorder.
3. Schedule follow-up sessions.
4. Thank the participant for their time.

Appendix D: Teacher Map of Resources

MAP OF RESOURCES

Please label each circle with the resources that you find most effective in teaching mathematics (with the circle closest to you being the most relied upon resource). If it's hard to narrow your list to 4, remember there is a space for "other resources" so that you have the opportunity to list additional resources that might just miss your "top 4."

I am a good at my
job because of....



Other Resources: (if needed)

Appendix E: Resource Diary

10/13/2018

Resource Diary

Resource Diary

You are being asked to complete this resource diary for three days (over a two-week period) for your participation in a research study aimed to understand resources and dilemmas of middle and high school mathematics teachers.

In the sections below you describe a lesson you taught today. You will be asked about the topic, resources you found effective to plan and teach with, and if there were any problems that arose when you were planning or teaching that you had to work through. If you have any questions (or experience any issues) please contact Michael Lawson by email (mlawso13@vols.utk.edu) or phone (865-441-2398).

* Required

1. Name *

2. Date *

Example: December 15, 2012

3. General Topic of Lesson

4. General Description of Lesson

5. What resources did you use to plan this lesson?

6. What resources did you use during this lesson?

7. What was the most effective resource you used to plan this lesson? What made using this resource effective while planning?

8. What was the most effective resource you used to teach this lesson? What made the use of this resource effective during the lesson?

9. Was there anything problematic that arose in the planning or teaching of this lesson? If so, please explain the problem and how you worked through it.

10. Are there any resources you wish you'd had or used to plan or teach this lesson? How would this resources have better supported your planning or teaching?

Appendix F: Guide for Observational Field Notes

Resource-Based Observation Form

Teacher:	Class:	School:
Date:	Time:	
Resources		
In-use and/or Available (explicit)		
In-Use and rendered invisible (implicit)		
Absent (null)		
Dilemmas		

Observational Notes:

Wondering:

VITA

Michael Andrew Lawson was born in Atlanta, Georgia, to Cynthia Lawson and Gary Lawson on August 24, 1989. Most of his childhood was spent in Johnson City, Tennessee, where he graduated from Science Hill High School. He also spent time growing up in Atlanta, Georgia, and Sarasota, Florida, where his father lived after his parent's separation. He studied mathematics and received his Bachelor of Sciences in mathematics from the University of Tennessee. Upon graduation he was a NOYCE fellow and participated in the TeachHere urban residency program through the University of Tennessee, Knoxville. By participating in this program, Michael gained field experience as a secondary mathematics teacher at Central High School and conducted his first research study on parent involvement in secondary mathematics. Following his residency, Michael taught at Central High School and later practiced as a secondary mathematics instructional coach in Knoxville, Tennessee. From there he pursued a doctoral degree in education with a concentration in teacher education and a specialization in mathematics education at the University of Tennessee, Knoxville.